Preconception Health and Care

Perspectives from the reproductive-aged population in Flanders

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PRECONCEPTION HEALTH AND CARE:

PERSPECTIVES FROM THE REPRODUCTIVE-AGED POPULATION IN FLANDERS

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LISTS OF ABBREVIATIONS

e.g.	For example
CDC	Centers for Disease Control and Prevention
CMV	Cytomegalovirus
COMET	Core Outcome Measures in Effectiveness Trial
CROWN	Core Outcomes in Women's and Newborn Health
DTP	Diphtheria-tetanus-pertussis
EUROCAT	European Surveillance of Congenital Anomalies
FAS	Fetal Alcohol Syndrome
FKGL	Flesch-Kincaid Grade Level
FRES	Flesch Reading Ease Score
GBS	Group B streptococcus
HC	Healthcare
IPV	Intimate partner violence
LMUP	The London Measure of Unplanned Pregnancy
MMR	Measles-mumps-rubella
MSPSS	Multidimensional Scale of Perceived Social Support
PC	Preconception care
PCA	Principal components analysis
PSS	Perceived Stress Scale
OR	Odds Ratio
RR	Relative Risk
SES	Socio-economic Status
SPE	Study Centre for Perinatal Epidemiology
STD	Sexually transmitted disease
TBS	Tuberculosis
WHO	World Health Organization

CHAPTER 1

GENERAL INTRODUCTION

1. The importance of preconception health and care

Improving maternal health and reducing child mortality are global health objectives, and have been identified as two health targets of the Sustainable Development Goals for 2030 that build on the Millennium Development Goals (United Nations, 2015a, b). Despite a considerable decrease of maternal and perinatal mortality between 1990 and 2015, efforts remain necessary to further improve maternal and perinatal health, and to reduce maternal and infant mortality (United Nations, 2015a, b; You et al., 2015; Alkema et al., 2016). Several studies have shown that an increasing number of reproductive-aged women and men have unhealthy lifestyle habits, are exposed to environmental hazards, and suffer from various medical conditions that increase the risk of spontaneous pregnancy loss, congenital disorders, preterm weight, and other adverse reproductive outcomes (Johnson et al., 2006; Dunlop et al., 2008b; Floyd et al., 2008; Creanga et al., 2014; Lu et al., 2015; Ornoy et al., 2015; Catalano and Shankar, 2017; Hirshberg and Srinivas, 2017; Poels et al., 2017d). For example, a cross-sectional study in the Netherlands with 481 presumed 'low-risk' couples wishing to become pregnant within one year, revealed that most couples reported several risk factors for adverse pregnancy outcome. In total, 47% of the couples reported medication use that is considered to be unsafe during pregnancy, 82% of the women and 92% of the men consumed alcohol, 22% of the women and 37% of the men smoked, 26% of the women were overweight or extreme overweight, and 6% of the women and 4% of the men reported a disease or disorder with possible consequences for a future pregnancy (van der Pal-de Bruin et al., 2008). In Flanders (Northern part of Belgium), similar prevalence estimates have been reported. For example, a population-based cohort study of Bogaerts et al. (2013) found that approximately 25% of the women who gave birth in Flanders were overweight or obese before their first pregnancy, and more than 31% before their second pregnancy (Bogaerts et al., 2013). In addition, results of the health inquiry of 2013 suggests that 86% of the women and 88% of the men in Flanders aged 25 to 34 years consumed alcohol during the last 12 months (Gisle and Demarest, 2014), 17% of the women and 30% of the men smoked (Gisle, 2014), 2% of the women were hypertensive (Van der Heyden, 2014), 1% of the women had diabetes (Van der Heyden, 2014), 3% of the women had asthma (Van der Heyden, 2014), and 3% of the women had a thyroid disorder (Van der Heyden, 2014).

The fetus is particularly vulnerable for lifestyle and environmental exposures during the periconceptional period, defined as 14 weeks before and 10 weeks after conception (Steegers-Theunissen et al., 2013). This definition is based on the physiology of the female and male reproduction, and the best implementation strategies for preconception care and research. Epigenetic modifications to the DNA of the oocyte can make the female gamete sensitive to external influences such as lifestyle influences. These epigenetic modifications can occur during the full ovarian follicular development period, but the most active phase of ovarian follicular

development is around 14 weeks preconception (Steegers-Theunissen et al., 2013). In men, the comparable preconceptional phase, the process of spermatogenesis, takes approximately 10 weeks (Heller and Clermont, 1964, Steegers-Theunissen et al., 2013). This preconceptional period is followed by the post-conceptional phase until 10 weeks after conception, in which organogenesis and placental development occurs (Hacker et al., 2010; World Health Organization, 2012; Steegers-Theunissen et al., 2013). By the time women discover they are pregnant or enter antenatal care, most fetal organs are developed (Johnson et al., 2006; Atrash et al., 2008; Moos, 2010). At that time, it is too late to prevent several of the adverse reproductive outcomes that are the consequence of parental risk factors that were present before the conception (Johnson et al., 2006; Atrash et al., 2008; Goossens et al., 2016). Therefore, it is important to act before the pregnancy, and offer a primary prevention approach (Atrash et al., 2008; Temel et al., 2015).

Preconception care is a type of primary prevention for the future child, and primary, secondary, and tertiary prevention for the mother- and father-to-be (Johnson et al., 2006; Moos, 2010; Temel et al., 2015). The basic idea of preconception care is to assure that a woman and man are healthy before they become pregnant in order to improve reproductive outcomes (Johnson et al., 2006; Posner et al., 2006; World Health Organization, 2012; Temel et al., 2015). Several studies have shown that improving preconception health and reducing parental risk factors can lead to improved pregnancy outcomes and reduced maternal and childhood mortality and morbidity, with the potential of economic benefits (Korenbrot et al., 2002; Johnson et al., 2006; Wahabi et al., 2010; Yi et al., 2011; Ramakrishnan et al., 2012; Wahabi et al., 2012; World Health Organization, 2012; Shannon et al., 2013; Dean et al., 2014; Shannon et al., 2014a; Lan et al., 2017). In addition, growing evidence supports the "Barker hypothesis" or "fetal programming hypothesis" that an adverse intrauterine environment affects the fetus's organs and systems permanently, and therefore, can lead to a wide range of disorders in adult life (Osmond and Barker, 2000; Rees et al., 2008; Smith and Ryckman, 2015; Holroyd et al., 2016). For example, undernutrition during the pregnancy can result in structural and functional changes in the fetus. These changes are associated with an increased risk of cardiometabolic diseases in adulthood, such as cardiovascular diseases, diabetes, and obesity (Osmond and Barker, 2000; Rees et al., 2008; Smith and Ryckman, 2015; Holroyd et al., 2016).

2. Definitions of preconception health and care

Preconception health and care are no new concepts, but have only been gaining attention in the last four decades (Hood et al., 2007). In the evolution of the modern practice of obstetrics, preconception care became a specialty that was separated from prenatal care (Freda et al., 2006). Since the decade of the 1980s, the dominant model of prenatal care begun to recognize the importance of preconception care (Freda et al., 2006).

Numerous definitions for preconception care have been formulated (Moos and Cefalo, 1987; Jack and Culpepper, 1990; Rosen et al., 1991; Allaire and Cefalo, 1998; Freda et al., 2006; Temel et al., 2015). For example, The World Health Organization (WHO)(2012) defined preconception care as "the provision of biomedical, behavioral and social health interventions to women and couples before conception (both before a pregnancy and between subsequent pregnancies)" (World Health Organization, 2012). However, the most frequently applied definition of preconception care is that of the Centers for Disease Control and Prevention (CDC) and the March of Dimes (2005), who described preconception care as "a set of interventions that aim to identify and modify biomedical, behavioral, and social risks to a woman's health or pregnancy outcome through prevention and management" (Johnson et al., 2006; Posner et al., 2006). In 2015, a Dutch national summit of preconception care proposed an adapted version of the definition of the CDC and March of Dimes, which resulted in the following definition: "A set of interventions and/or programs that aims to identify and enable informed decision-making to modify biomedical, behavioral, and (psycho) social risks to parental health and the health of their future child, through counseling, prevention and management, emphasizing those factors that must be acted on before conception and in early pregnancy, to have maximal impact and/or choice" (Temel et al., 2015).

In contrast to preconception care, few definitions have been formulated for the term 'preconception health'. The Centers for Disease Control and Prevention (CDC) defined preconception health as "the health of women and men during their reproductive years" (Centers for Disease Control and Prevention, 2014). Other studies described preconception health as the health of women (and men) prior to (or between) pregnancies (Delgado, 2008; Mitchell and Verbiest, 2013; Toivonen et al., 2017).

The aforementioned definitions of preconception health and care suggest that the preconception period technically comprises any point before the conception (Toivonen et al., 2017). A benefit of conceptualizing the preconception period in this manner is that preconception health is perceived as part of a general healthy lifestyle, and not just a in a short period before the conception (Toivonen et al., 2017). A disadvantage of this approach is that it is more difficult to follow recommendations, which might decrease the compliance in the general population. Another way of conceptualizing the preconception period is in terms of months or years before the conception, which is often used in preconception health research. The WHO (2012) used the term 'proximal preconception care' to delineate a limited period of up to 2 years before conception occurs, and 'distal preconception care' to which no time limits has been ascribed. The periconception period is further delineated to a limited period around the conception, for example 3 months before and 3 months after the conception (World Health Organization, 2012), or 14 weeks before and 10 weeks after conception (Steegers-

Theunissen et al., 2013). An advantage of conceptualizing preconception care in short versus long term recommendations is that they are easier to follow. A disadvantage of the latter approach is that some individuals make lifestyle changes for a short period instead of perceiving preconception behaviors as part of a long-term healthy lifestyle (Toivonen et al., 2017).

3. Content of preconception care

Guidelines for preconception care were first developed in the beginning of the previous decade (Freda et al., 2006). Between 2005 and 2007, a panel of experts on preconception care elaborated on the clinical content of preconception care (Jack et al., 2008). The workgroup recommended that the elements of preconception care include (1) the provision of health promotion that is tailored to a woman's and man' needs, (2) a systematic identification of risk factors that might affect future pregnancy outcomes (risk assessment), and (3) interventions to reduce these risk factors (Jack et al., 2008; Moos et al., 2008). The clinical content of preconception care was identified through a systematic review regarding preconception care, and the domains and topics were selected on the basis of the effect of preconception care on the maternal and infant health, the prevalence, and the detectability (Jack et al., 2008). For each topic, the workgroup rated the quality of the evidence and the strength of the recommendation.

In total, 13 domains of preconception care were identified, including (1) health promotion activities, such as family planning and reproductive life plan (Moos et al., 2008); (2) immunization (Coonrod et al., 2008a); (3) infections (Coonrod et al., 2008b); (4) chronic medical conditions (Dunlop et al., 2008b); (5) psychiatric conditions (Frieder et al., 2008); (6) alcohol, tobacco, and illicit drug exposures (Floyd et al., 2008); (7) family and genetic history (Solomon et al., 2008); (8) nutrition and dietary supplements (Gardiner et al., 2008); (9) environmental exposures (McDiarmid et al., 2008); (10) psychosocial stressors (Klerman et al., 2008); (11) medications and supplements (Dunlop et al., 2008a); (12) reproductive history (Stubblefield et al., 2008); and (13) special populations (Frey et al., 2008; Ruhl and Moran, 2008).

Table 1 provides an overview of the strength of the recommendations and the quality of evidence for each preconception topic, based on the study of Jack et al. (2008) and Temel et al. (2015). Both Jack et al. (2008) and Temel et al. (2015) assessed the strength of the recommendation and evidence according to the US Preventive Services Task Force Guide of Clinical Preventive Services (US Preventive Services Task Force, 1996). Following criteria were used to determine the strength of evidence of each preconception topic; A: there is good evidence to support the recommendation of including the topic in preconception care practice; B: there is fair evidence to support the recommendation of including the topic in preconception care practice; C: there is insufficient evidence to recommend for or against the inclusion of the topic in preconception care practice, but

the inclusion or exclusion may be made on other grounds; D: there is fair evidence to support the recommendation of excluding the topic in preconception care practice; E: there is good evidence to support the recommendation of excluding the topic in preconception care practice. The quality of the evidence was assessed using the following criteria; I-a: evidence was obtained from at least 1 properly conducted randomized controlled trial that was conducted prior to pregnancy; I-b: evidence was obtained from at least one properly conducted randomized controlled trial that was conducted not necessarily prior pregnancy; II-1: evidence was obtained from well-designed controlled trials without randomization; II-2: evidence was obtained from well-designed cohort or case-control studies, preferably from more than 1 center or research group; II-3: evidence was obtained from time series with or without the intervention; III: evidence based on clinical experience, opinions from respected authorities, descriptive studies and case reports, or reports of expert committees.

Overall, the quality of the evidence to support the inclusion of a preconception care topic varies greatly (Jack et al., 2008; Temel et al., 2015). There is strong evidence for only a few preconception care topics, including folic acid, diabetes mellitus, tobacco and alcohol exposures, and previous miscarriage or preterm birth. Given the lack of evidence for several preconception topics, further research is indicated (Jack et al., 2008; Temel et al., 2015).

Table 1. Strength of the recommendations and the quality of the evidence for preconception topics

Domains of preconception care[1,2]	Strength[1]	Quality (2008)[1]	Quality (2015)[2]
Health promotion			
Family planning	A	III	III
Physical activity	C	II-2	II-2
Immunization			
Measles, mumps, and rubella	A	II-3	II-3
Hepatitis B	A	III	III
Human papillomavirus (HPV)	B	II-2	II-2
Varicella	B	III	III
Diphtheria-tetanus-pertussis	B	III	III
Influenza	C	III	III
Infection			
Chlamydia	A	I-a	II-2
Human immunodeficiency virus	A	I-b	I-b
Syphilis	A	II-1	I-a
Tuberculosis	B	II-2	II-2
Gonorrhea	B	II-2	III
Herpes simplex virus	B	II-1	II-1
Periodontal disease	C	I-b	I-b
Cytomegalovirus	C	II-2	III
Toxoplasmosis	C	III	II-2
Hepatitis C	C	III	III
Listerosis	C	III	/
Malaria	C	III	III
Group B Streptococcus	E	I-b	II-2
Asymptomatic bacteruria	E	II-1	II-1
Parvovirus	E	III	III
Bacterial vaginosis	D: women without preterm delivery C: women with preterm delivery	I-b	I-b
Medical conditions			
Diabetes mellitus	A	I-a	I-a
Thyroid disease	A	II-1	II-1
Phenylketonuria	A	II-1	II-1
Seizure disorders	A	II-2	II-2
Hypertension	A	II-2	II-2
Rheumatoid arthritis	A	III	III
Lupus	B	II-2	II-2
Chronic Renal disease	B	II-2	II-2
Cardiovascular disease	B	III-3	II-2/II-3
Thrombophilia	C: women using no warfarin B: women using warfarin	III II-3	II-3
Asthma	B	II-3	II-3
Psychiatric condition			
Depression/anxiety	B	III	II-2
Bipolar disease	B	III	II-2
Schizophrenia	B	III	II-2
Maternal exposure			
Tobacco	A	I-a	I-a
Alcohol	B	I-a	I-a

Illicit substances	C	III	II-2
Family and genetic history			
Ethnicity-based	B	II-3	II-3
Positive family history	B	II-3	II-3
Known genetic conditions	B	II-3	II-3
All individuals	B	III	II-2
Previous pregnancies	C	III	III
Nutrition			
Folic acid	A	I-a	I-a
Calcium	A	I-b	/
Iron	A	I-b	/
Overweight	A	I-b	I-b
Multivitamins	A	II-2	/
Iodine	A	II-2	/
Underweight	A	III	II-2
Eating disorders	A	III	III
Essential fatty acids	B	I-b	/
Vitamin D	B	II-3	II-3
Vitamin A	B	III	III
Dietary supplements	C	III	
Environmental exposure			
Household exposure	A	III	III
Mercury	B	III	/
Soil and water hazards	B B (BPA avoidance)	III II	/
Workplace exposure	B	III	II-2
Lead	C	II-2	/
Psychosocial risk			
Inadequate financial resources	C	III	II-2
Access to care	C	III	/
Physical/sexual abuse	C	III	II-2
Medication			
Prescribed medication	A	II-2	II-1
Over-the-counter medication	A	III	III
Herbs/herbal products/ dietary supplements	A	II-3	II-1
Reproductive history			
Prior preterm birth	A	I-a	I-a
Prior miscarriage	A	I-a	I-a
Prior cesarean delivery	A	II-2	II-2
Prior stillbirth	B	II-2	II-2
Uterine anomalies	B	II-3	II-3
Special groups			
Cancer survivors	A	III	II-2
Immigrant and refugee populations	B	III	II-2
Women with disabilities	B	III	III
Men	B	III	/

[1]Based on the study of Jack et al. (2008); [2]Based on the study of Temel et al. (2015)

4. Clinical and economic effectiveness of preconception interventions

4.1 Clinical effectiveness of preconception care interventions

To date, the effectiveness of preconception care interventions to reduce risk factors and adverse pregnancy outcomes remains partially unclear. A handful systematic reviews have summarized the available effectiveness of some preconception care interventions in terms of maternal behavioral change and/or pregnancy outcome (De-Regil et al., 2010; Dean et al., 2014; Shannon et al., 2014a; Temel et al., 2014; Opray et al., 2015; Temel et al., 2015; Hussein et al., 2016; Toivonen et al., 2017). On the basis of these results, an overview of the available effectiveness of all preconception care interventions in terms of maternal behavioral change and the reduction of congenital malformations was provided, together with a prioritization of preconception care interventions through a ranked score-based system. The ranked scoring system was created based on the study of Shannon et al. (2014a) and incorporated: (1) the strength of the evidence supporting the intervention-based effect on maternal behavior change and/or reduction of congenital anomalies, (2) the effect size of the intervention, and (3) the burden of the congenital disease (Table 2). The strength of the evidence was scored by allocating a rank order to the hierarchy of the study design according to the Oxford Centre for Evidence Based Medicine – Levels of Evidence, with a score 7 for a meta-analysis, a score 6 for a systematic review, a score 5 for a RCT, a score 4 for a prospective study, a score 3 for a retrospective study, a score 2 for audit, and a score 1 for an opinion article. The effect size of the intervention was scored based on their Odds Ratio (OR) or Relative Risk (RR), with a higher impact of an intervention receiving a higher score. The score ranged between 12 (representing an OR/RR lower than 0.2) and 2 (representing an OR/RR above 1.0). If no OR or RR was reported, a score 0 was given. The burden of the congenital disease was obtained from the "European Surveillance of Congenital Anomalies" (EUROCAT), an epidemiological surveillance of congenital anomalies, and EUROmediCAT, a reproductive pharmacovigilance system that builds further on the EUROCAT, and was scored by rank order of prevalence (Given et al., 2016; Nelen et al., 2017). If available, the prevalence of a congenital anomaly in Flanders was used. If the prevalence was unavailable for Flanders, an overall European prevalence was derived. If no prevalence data was available, a literature search was conducted and the rank order of the burden of congenital disease was based on the one of Shannon et al. (2014a). A score was calculated for both interventions in terms of maternal behavior change and reduction of congenital anomalies. These scores were summed, and then ranked to prioritize the preconception interventions that are likely to have the highest impact. As can be derived from Table 2, the most effective available preconception care interventions, with the largest impact, include folic acid supplementation or fortification, diabetes management, alcohol intervention, medication counseling, and prevention and/or management of infectious diseases. Table 2 also illustrates the lack of preconception care interventions for specific risk factors including unplanned pregnancies, physical

inactivity, specific chronic medical conditions (e.g. asthma and chronic renal diseases), psychiatric conditions, genetic risks, environmental exposures, reproductive history, and psychosocial stressors (Dean et al., 2014; Shannon et al., 2014a; Temel et al., 2014; Opray et al., 2015; Temel et al., 2015; Hussein et al., 2016; Toivonen et al., 2017). If preconception care interventions were available, most of the included studies showed some risk of bias (Shannon et al., 2014a; Temel et al., 2014; Temel et al., 2015; Hussein et al., 2016). It should also be noted that many of the original studies do not describe the details of the intervention development thoroughly (Temel et al., 2014). In addition, most of these interventions were development without a theoretical framework or an overview of factors that were targeted it in the intervention, making it difficult to draw conclusions regarding the effect of an intervention. For interventions focusing on pregnancy outcome, there was often a lack of experimental studies which may be due to the nature of the risk factor or ethical considerations, for example with illicit substances, smoking, obesity, and infection diseases (Shannon et al., 2014a). Although reduction of congenital anomalies was the most frequently used pregnancy outcome variable in the included studies, other reproductive outcome variables (e.g. birth weight) were not assessed in this study, which may underestimate the effect of a specific intervention. In addition, only results for interventions focused on women were provided due to fact that all but one (Toivonen et al., 2017) reviews included or drew information for females only (De-Regil et al., 2010; Dean et al., 2014; Shannon et al., 2014a; Temel et al., 2014; Opray et al., 2015; Temel et al., 2015; Hussein et al., 2016). Studies focusing on maternal behavioral change often lacked follow-up of behavioral change during a subsequent pregnancy (Temel et al., 2014). For both interventions in terms of maternal behavioral change and pregnancy outcome, methodological differences and differences in outcome measures led to heterogeneous data, which made it impossible to pool data (Temel et al., 2014; Hussein et al., 2016).

Overall, the above review of the evidence available about the effectiveness of preconception care interventions emphasizes the need for more research in specific preconception care domains, including pregnancy planning, medical and psychiatric conditions, psychosocial stressors, genetic risks, and environmental exposures. In addition, to minimize reporting bias and to facilitate pooling of data and meta-analysis, it would be interesting to develop a core set of fetal and maternal outcome measures for preconception interventions (Khan and Romero, 2014; Duffy et al., 2017; Williamson et al., 2017). Core outcome sets are agreed minimum collections of outcomes that are measured and reported in a standardized manner (Duffy et al., 2017). To the author's knowledge, no core outcome sets for overall preconception care interventions are available in the literature or registered to the "Core Outcome Measures in Effectiveness Trial" (COMET) initiative register or "Core Outcomes in Women's and Newborn Health" (CROWN) initiative register. Only a core outcome set for obesity (COMET registration number: 784, no published core outcome sets) and pregestational diabetes (COMET registration

number: 692, published core outcome sets) included aspects of preconception care. The study regarding pregestational diabetes mellitus developed a core outcome set for trials and other studies evaluating the effectiveness of preconception care for women with pregestational diabetes mellitus. In total, 17 outcomes were included in the final core outcome set and grouped under three domains: measures of pregnancy preparation (e.g. use of folic acid preconception), neonatal outcomes (e.g. congenital malformations), and maternal outcomes (e.g. gestational weight gain) (Egan et al., 2015; Egan et al., 2017). For a core outcome set evaluating the effectiveness of preconception care interventions, it would be interesting to develop a generic data set of core outcomes that can be supplemented with additional outcomes to meet the needs of different target populations, settings or domains of preconception care.

Table 2. Overview of the available effectiveness of preconception care interventions and prioritization of the interventions through a ranked score-based system

Domain of preconception care	Risk factor	Intervention	Burden of disease	Intervention outcome: maternal behavioral change			Intervention outcome: reduction congenital disease			TOTAL INTERVENTION SCORE[4]	RANK[5]
				Strength of evidence[1]	Effect size[2]	Total score[3]	Strength of evidence[1]	Effect size[2]	Total score[3]		
Health promotion	Lack of physical activity	Screening and intervention	0[#]	5	8	**13**	1	0	**1**	14	**8**
Immunizations	Infectious diseases	Vaccination for preventable infection diseases (MMR, HPV, hepatitis B, varicella, influence, DTP)	9[##]	2	0	**11**	1	0	**10**	21	**6**
Infection	Infectious diseases	Screening and/or prevention (STD, CMV, toxoplasmosis, periodontal disease, GBS, TBC, hepatitis C, parvovirus, malaria)	9[##]	4	0	**13**	1	0	**10**	23	**5**
Chronic medical conditions	Diabetes	Education and disease optimization	4[$]	7	0	**11**	7	10	**21**	32	**2**
	Seizure disorders	Education and disease optimization	6[$$]	6	0	**12**	6	0	**12**	24	**4**
	Thyroid disease	Education and disease optimization	5*	1	0	**6**	3	0	**8**	14	**8**
	Phenylketonuria (PKU)	Dietary modification	1**	1	0	**2**	6	0	**7**	9	**11**
Medication	Medication use	Medication counseling	8[$]	5	2	**15**	1	0	**9**	24	**4**
Maternal exposure	Alcohol	screening and intervention	7[$$]	7	4	**18**	1	0	**8**	26	**3**
	Smoking	screening and intervention	3°	6	2	**11**	1	0	**4**	15	**7**
	Illicit substances	screening and intervention	1°°	1	0	**2**	1	0	**2**	4	**12**
Nutrition	Poor Inadequate dietary intake	Dietary modification	1[µ]	5	0	**6**	4	0	**5**	11	**10**
	Inadequate folate intake	Supplementation	10[µµ]	7	12	**29**	7	10	**27**	56	**1**
		Fortification	10[µµ]	NA	NA	**/**	7	10	**27**	27	**1**
	BMI > 30 kg/m²	Individualized weight loss program	2[ɛ]	5	3	**10**	1	0	**3**	13	**9**

[1]Scoring system "strength of evidence" [based on hierarchy of study design as per Oxford Centre for Evidence Based Medicine used in Shannon et al. (2014a)]: Meta-analysis = 7; Systematic review = 6; RCT = 5; prospective study = 4, retrospective study = 3; audit = 2; opinion article = 1 – highest level of evidence reported.
[2]Scoring system "effect size of intervention" [based on scoring system used in Shannon et al. (2014a)]: RR/OR 0.01-0.2 = 12; RR/OR 0.21-0.4 =10; RR/OR 0.41-0.6 = 8; RR/OR 0.61 -0.8 = 6; RR/OR 0.81-1.0=4; RR/OR > 1.0 or not significant = 2; not reported RR/OR = 0 – highest size effect reported.
[3]Total score is sum of (1) the burden of disease and (2) strength of evidence and (3) effect size of the intervention.
[4]Total score is the sum of the total intervention scores regarding maternal behavioral change and reduction congenital anomalies.

[#]To the authors knowledge, no studies investigated the association between physical inactivity and congenital anomalies.
[##]Prevalence of maternal infections resulting in malformations as the European Surveillance of Congenital Anomalies (EUROCAT) reports in Flanders: 1.84 per 10 000 births (registration years 1989 – 2014) (Nelen et al., 2017).
[$]Prevalence of congenital anomalies related to diabetes as the EUROCAT reports in study "Spectrum of Congenital Anomalies in Pregnancies with Pregestational Diabetes": 0.017 per 10 000 births (669 congenital anomalies in diabetes cases / 3 729 230 registered births in 1990 – 2005)(Garne et al., 2012).
[$$]Prevalence of Valproate syndrome as the EUROCAT reports in Flanders: 0.04 per 10.000 births (registration years 1989 – 2014)(Nelen et al., 2017).
*Prevalence congenital anomalies related to thyroid therapy as the EUROmediCAT reports in the study "EUROmediCAT signal detection: a systematic method for identifying potential teratogentic medication" and their final report: 0.018 per 10 000 births (1 298 fetuses with congenital anomalies exposed to thyroid therapy / 7,2 million births in the period 1995 – 2012) (Given et al., 2016; Loane et al., 2017).
**No prevalence in EUROCAT. Scoring based on Shannon et al. (2014a).
[$]Prevalence of congenital anomalies related to medication use during the first trimester as the EUROmediCAT reports in study "EUROmediCAT signal detection: a systematic method for identifying potential teratogentic medication" and their final report: 0.21 per 10 000 births (14 950 fetuses with medication exposure during first trimester and congenital anomalies / 7,2 million births in the period 1995 – 2012) (Given et al., 2016; Loane et al., 2017).
[$$]Prevalence of Fetal Alcohol Syndrome (FAS) as EUROCAT reports in Flanders: 0.05 per 10 000 births (registration years 1989 – 2014) (Nelen et al., 2017).
°Prevalence of deformities of the foot associated with maternal smoking as the EUROCAT reports in the study "Maternal smoking and deformities of the foot: results of the EUROCAT Study. European Registries of Congenital Anomalies": 0.006 per 10 000 births (4.5% of the 3662 cases of deformities of the foot were attributed to maternal smoking / 2 853 474 births)(Reefhuis et al., 1998).
°°No prevalence available by EUROCAT. Mixed results in literature regarding association substance abuse and congenital anomalies (Viteri et al., 2015; Lind et al., 2017).
[µ]No prevalence available by EUROCAT. Mixed results in literature regarding association maternal nutrition and congenital anomalies (Groenen et al., 2004; Smedts et al., 2008; Feldkamp et al., 2011; Beurskens et al., 2013; Huber et al., 2013; Feldkamp et al., 2014; Botto et al., 2016).
[µµ]Prevalence of neural tube defects as the EUROCAT reports in Flanders: 8.79 per 10 000 births (registration years 1989 – 2014) (Nelen et al., 2017).
[&]No prevalence available by EUROCAT. Several systematic reviews and meta-analyses showed an increased risk of neural tube defects and congenital heart defects in women with obesity in the prepregnancy period or early pregnancy (Stothard et al., 2009; Dean et al., 2014; Marchi et al., 2015). For example: OR of 1.87 (95% CI: 1.62–2.15) for neural tube defects and OR of 1.30 (95% CI, 1.12 – 1.51) for cardiovascular anomalies (Stothard et al., 2009), and OR of 1.15 (95% CI, 1.07-1.24) for neural tube defects and congenital heart defects (Dean et al., 2014).

4.2 Economic effectiveness of preconception care interventions

Despite the fact that the CDC and WHO recommended to design and conduct analyses of cost-effectiveness and cost-benefit of preconception care interventions, only a few economic studies have been done (Johnson et al., 2006; World Health Organization, 2012). Peterson et al. (2015) estimated the preventable health and cost burden of adverse birth outcomes associated with pregestational diabetes in the United States. They estimated that preconception care might prevent thousands of adverse reproductive outcomes among US women with pregestational diabetes annually, and lead to lifetime societal cost savings of up to $5.5 billion (Peterson et al., 2015). Due to a lack of robust preconception care costs estimates, they did not consider the costs of preconception care in their economic analysis. Yi and colleagues (2011) investigated the economic impact of preventing neural tube defects with folic acid by performing a systematic review. The results from the economic evaluations showed that folic acid supplementation or fortification are cost-effective ways of preventing neural tube defects (Yi et al., 2011). Weijers-Poppelaars et al. (2005) evaluated the costs and effects of preconception cystic fibrosis carrier screening. The study showed a favorable costs-saving balance of screening, but the balance was very sensitive to lifetime costs of care for a patient with cystic fibrosis, of which no recent data were available (Weijers-Poppelaars et al., 2005). Based on the above, it is recommended to incorporate economic evaluations into intervention studies. Economic evaluations are important because the results can convince decision-makers and funders about the importance of preconception care, and can help them in the decision making process of allocating healthcare resources (Johnson et al., 2006; World Health Organization, 2012; Salihu et al., 2013).

5. Organization of preconception care

It is recommended to tailor the organization of preconception care to the needs and epidemiological situation of a country and its population, the resources available, and the cultural aspects (World Health Organization, 2012). One of the major challenges regarding preconception care is to identify how it can be organized to improve its uptake (Lassi et al., 2014; Shannon et al., 2014b; Poels et al., 2017b).

5.1 Target population

No (inter)national consensus exists regarding the target population of preconception care (Temel et al., 2015). The target population can be divided into three groups (World Health Organization, 2012; Temel et al., 2015): (1) the general reproductive-aged population; (2) women and men planning to conceive, who might be more receptive to input on what they can do to increase the likelihood of a healthy pregnancy and child; and (3) high-risk groups, including women and men in difficult social situations, those who have had previous poor

pregnancy outcomes, and those with known medical disorders (van der Zee et al., 2011; World Health Organization, 2012). The CDC and WHO recommend to first target women at highest risk (who are contemplating a pregnancy), because most of the adverse pregnancy outcomes are observed in this small subgroup of women (Johnson et al., 2006; World Health Organization, 2012).

5.2 Delivery channels

It is recommended to deliver general preconception care to women and men through various delivery channels, both within and outside the health sector (World Health Organization, 2012; Lassi et al., 2014; Shannon et al., 2014b). An emphasizes is placed on the importance of integrating preconception care into ongoing programs (Moos, 2010; World Health Organization, 2012; Lassi et al., 2014). Moos (2010) argues that the majority of the women do not need further fragmentation of the healthcare delivery system through creating a new service, the so-called "preconception consultation". A special preconception visit is appropriate for high-risk groups, but there is nothing to recommend this for most of the women and men contemplating a pregnancy (Moos, 2010; Temel et al., 2015). Such an approach is expensive and is likely to miss the majority of the women becoming pregnant (Moos, 2010).

5.2.1 Delivery within health system

Preconception care can be delivered by healthcare providers in primary care, hospital and community health settings (Johnson et al., 2006). In theory, every health visit is an opportunity to provide preconception care (Johnson et al., 2006). It is estimated that 80% of the women and 76% of the men aged 25–34 years in Flanders come into contact with a general practitioner annually, and 37% of the women in Belgium consult a gynecologist annually (Drieskens and Gisle, 2015; Gunaïkeia, 2015). Therefore, opportunistic preconception care through healthcare settings is a potential strategy to address the majority of reproductive-aged people. However, it relies heavily on the motivation of healthcare providers to provide it, and bears the risk of overburden healthcare providers, who already have a lot to do (Atrash et al., 2008; World Health Organization, 2012; Shannon et al., 2014b). Especially community-based preconception care is labor- and resource-intensive, but has the ability to reach the most marginalized women and men (Shannon et al., 2014b). In addition, offering preconception care "out of the blue" may not always be appreciated by the target population (Poels et al., 2017b). Delivering preconception care opportunistically is considered more acceptable when the reason or content of a health visit is related to reproductive health, for example while discussing birth control, pap smears, chronic disorders, and medication prescriptions (Poels et al., 2017b).

5.2.2 Delivery outside health system

Preconception care can also be delivered outside healthcare settings, including through community based organizations and support groups, social welfare programs, workplace programs, and the educational system (World Health Organization, 2012; Lassi et al., 2014; Temel et al., 2015). Literature suggest that schools are important channels for endorsing preconception health and care because early sensitization could promote the importance of preconception health and the utilization of preconception care later in life (Edwards et al., 1997; Charron-Prochownik et al., 2006b; Delgado, 2008; Charafeddine et al., 2014; Lassi et al., 2014; Temel et al., 2015).

In addition to formal settings, marketing of preconception health and care can be done using a variety of methods, including mass media (e.g. television, radio, websites, and magazines), social media (e.g. Facebook, Instagram, and Twitter), and displaying marketing materials in public places such as the city hall, mosques, churches, grocery stores, library, cinema, gyms, swimming pool, and day care facilities to reach a vast majority of the population (World Health Organization, 2012; Lassi et al., 2014; Poels et al., 2017b).

5.3 Providers

Preconception care needs to be supported and provided by different actors with different relations to the target groups. The following healthcare providers play a potential important role in providing preconception care: midwives, nurses, (advanced) midwife/nurse practitioners, general practitioners, pediatricians, gynecologists, and medical specialists in general (Johnson et al., 2006; Atrash et al., 2008; Temel et al., 2015). In addition, paramedics, pharmacists, occupational health physicians, youth and family centers, health promotional organizations in general, peer educators, teachers, policymakers and so on that have a direct link or are a medium to the target population could also play an important role in the provision of preconception care (World Health Organization, 2012; El-Ibiary et al., 2014; Temel et al., 2015).

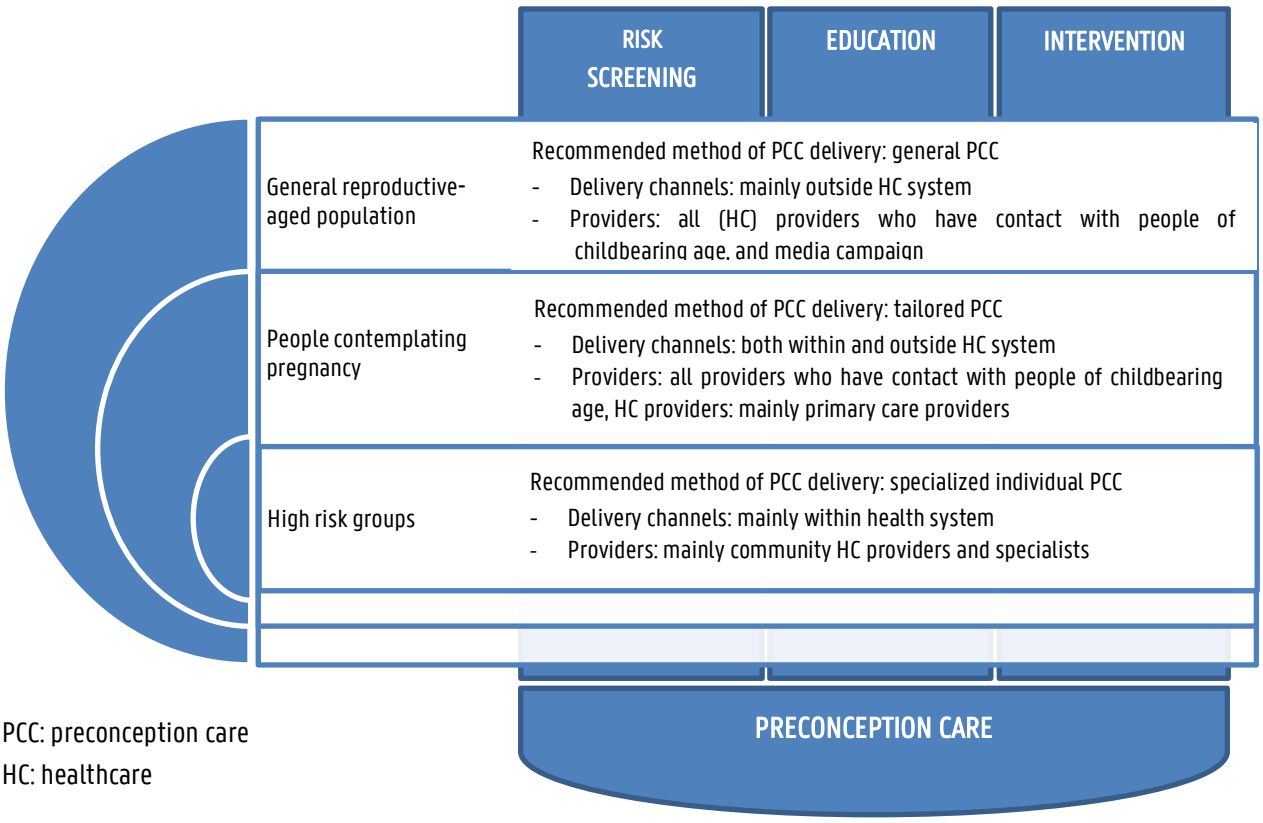
Based on the aforementioned overview of potential actors, one can conclude that all (healthcare) providers who have contact with reproductive-aged women and men share a responsibility in providing and supporting preconception care, which may reduce the sense of individual responsibility and efforts (Weldon and Gargano, 1985; Karau and Williams, 1993; Frayne et al., 2016; Shih and Susanto, 2016).

5.4 Packages

Preconception care can be focused on a single aspect of preconception health (e.g. folic acid supplementation to prevent neural tube defects) or on multiple aspects bundled together or co-packaged (Lassi et al., 2014; Toivonen et al., 2017). Although interventions that address multiple risk factors for adverse pregnancy outcome

simultaneously have not been well-studied, evidence suggest that these interventions may be equally effective and have advantages over a single intervention (Jack et al., 2008; Temel et al., 2014; Hussein et al., 2016). Several studies among pregnant women, non-pregnant women, and men demonstrated a clustering of behavioral risk factors, and especially among women and men of lower education and income, and those who are unemployed, or single (Poortinga, 2007; Erickson and Arbour, 2012; Page et al., 2012; Ferreira da Costa et al., 2013; Passey et al., 2014; Meader et al., 2016). For example, the cross-sectional study of Passey et al. (2014) with 257 pregnant Indigenous women attending antenatal services in Australia found that women using one substance (tobacco, alcohol or cannabis), were significantly more likely to also use other substances. Clustering of substance use was independently associated with lower educational attainment. A recent systematic review of Noble et al. (2015) examined the clustering of smoking, nutrition, alcohol, and physical activity health behaviors among adults. More than half of the included studies (56%) reported a clustering of smoking with alcohol, 50% reported a clustering of all four risk behaviors, and 44% reported a clustering of poor nutrition and physical inactivity. Greater social disadvantage was associated with more risky behaviors (Noble et al., 2015). These findings support the potential for interventions targeting multiple risk factors together, and especially among the subgroup of disadvantaged women and men.

Based on the above, an overview is provided of the organization of preconception care (Figure 1).



PCC: preconception care
HC: healthcare

Figure 1. Summary of the organization of preconception care

6. Factors associated with the use of preconception care: a socio-ecological approach

Despite the growing evidence of the importance of preconception health and care, many reproductive-aged women and men do not prepare for pregnancy (Frey and Files, 2006; Oza-Frank et al., 2014; Stephenson et al., 2014; Oza-Frank et al., 2015; Poels et al., 2016; Bodin et al., 2017). Research suggests that only 25% to 39% of the women or couples reported to receive preconception care from a healthcare provider (Frey and Files, 2006; Williams et al., 2012; Oza-Frank et al., 2014; Stephenson et al., 2014; Oza-Frank et al., 2015; Poels et al., 2017c). To implement preconception care, it is important to gain insight in factors influencing the uptake of preconception care (Bartholomew et al., 2016). Factors influencing adoption of preconception care are complex due to the multifactorial and multilevel influences (Bronfenbrenner, 1979; McLeroy et al., 1988; Posner et al., 2006; Moos, 2010; Bartholomew et al., 2016). The Social Ecological Model is a theory-based framework for understanding the multifaceted and interactive interplay between individual and environmental factors that influence behaviors (Bronfenbrenner, 1979; McLeroy et al., 1988; Bartholomew et al., 2016). The Social Ecological Model behavior acknowledges that individual behavior is influenced by a wide range of factors at individual, interpersonal, organizational, community, and societal level (Bronfenbrenner, 1979; McLeroy et al., 1988; Bartholomew et al., 2016). Based on the Social Ecological Model, the following influencing factors on the use of preconception care were identified (Figure 2).

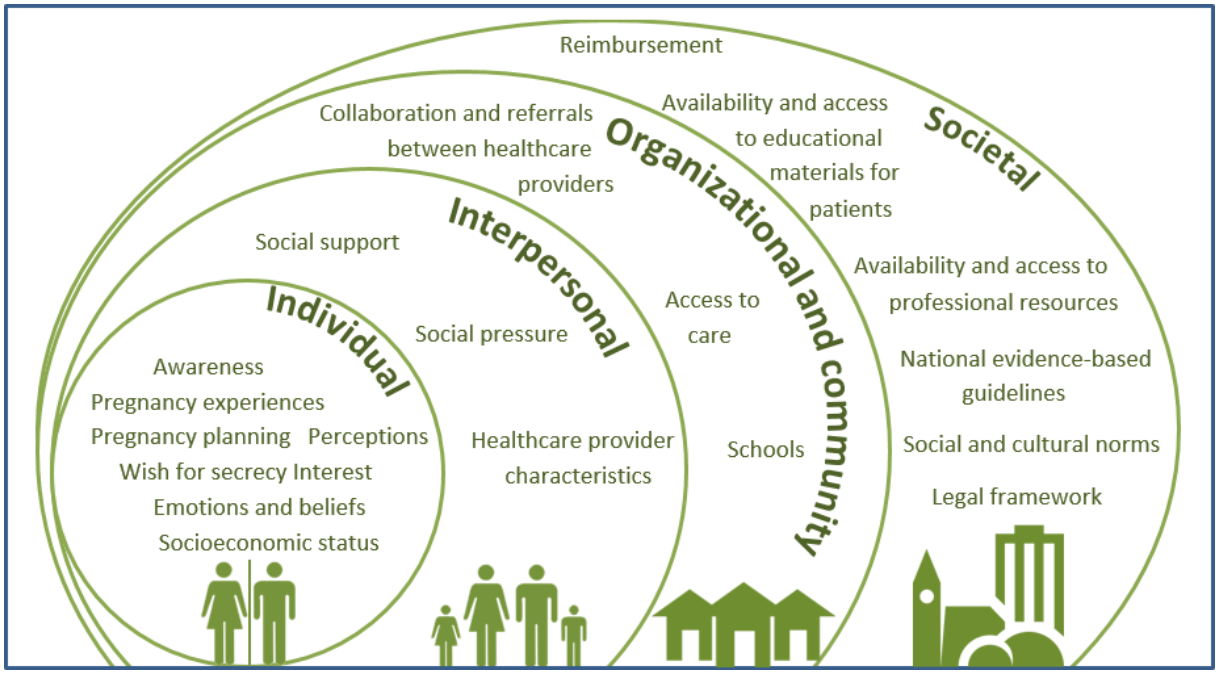


Figure 2. The Social Ecological Model applied to use of preconception care

Individual level

The individual level includes the characteristics of the individual such as sociodemographics, knowledge, attitudes, behaviors, and skills (Bronfenbrenner, 1979; McLeroy et al., 1988; Bartholomew et al., 2016).

Poels et al. (2016) conducted a systematic review to investigate which factors women perceive as barriers and facilitators for the use of preconception care. One of the most reported barrier was the *lack of awareness and unfamiliarity* with the concept of preconception care (Charron-Prochownik et al., 2006a; Canady et al., 2008; Murphy et al., 2010; Mitchell et al., 2012; Zhu et al., 2012; Squiers et al., 2013; Tuomainen et al., 2013; O'Higgins et al., 2014; Poels et al., 2017b). Moos (2010) argues that the term 'preconception care' is too clinical, and therefore, not understood by the targeted population. A qualitative study in the Netherlands using focus group sessions with women (n= 29) and men (n= 5) found that most participants were unfamiliar with the concept of preconception care. Almost all participants assumed preconception care was only appropriate in the presence of certain risk factors such as fertility issues (Poels et al., 2017b). Another frequently reported barrier for the use of preconception care was the *perception of being healthy enough*, and therefore, preconception care was considered as not relevant (Canady et al., 2008; Hosli et al., 2008; Mazza and Chapman, 2010; Murphy et al., 2010; Tuomainen et al., 2013; van der Zee et al., 2013; O'Higgins et al., 2014; Poels et al., 2017b). In addition, *past pregnancy experiences* was also identified as an important barrier for the use of preconception care, as multigravida women often believe that they have sufficient knowledge about preconception health (Wallace and Hurwitz, 1998; Hosli et al., 2008; Mazza and Chapman, 2010; Murphy et al., 2010; Zhu et al., 2012; Temel et al., 2013; Tuomainen et al., 2013; van der Zee et al., 2013). *Not (fully) planning a pregnancy* was another important impeding factor for the use of preconception care (de Jong-Potjer et al., 2003; Elsinga et al., 2006; Canady et al., 2008; Murphy et al., 2010; Spence et al., 2010; Zhu et al., 2012; Tuomainen et al., 2013; van der Zee et al., 2013). The probability that a woman will experience an unplanned pregnancy in her lifetime is significant. In 2002, 45% of the pregnancies in Europe were unintended, of which one fourth were continued (Sedgh et al., 2014). Other factors influencing the use of preconception care were *wish for secrecy*, *emotions and beliefs* about pregnancy and preconception care, *medicalization of conception*, and *interest* in preconception care (Canady et al., 2008; Mazza and Chapman, 2010; Murphy et al., 2010; Poels et al., 2017b).

Several studies have shown that women of lower *socioeconomic status* (based on education, employment, and income) have a high prevalence of risk factors for adverse pregnancy outcomes compared to women of higher socioeconomic status (van der Pal-de Bruin et al., 2008; Harelick et al., 2011; Timmermans et al., 2011; Denny et al., 2012; Weightman et al., 2012; de Graaf et al., 2013; Waelput et al., 2017). Although these women could benefit most from preconception care, literature suggests that women of lower socioeconomic status are less

likely to use preconception care compared to their lower risk counterparts (Elsinga et al., 2006; de Graaf et al., 2013). The so-called Matthew effect (Stanovich, 1986) – a phenomenon where the rich get richer and the poor get poorer – was also observed in several studies on preconception health and care: the healthy, low-risk women use healthcare services to become healthier while the less healthy, high-risk women do not use healthcare services and become unhealthier (van der Pal-de Bruin et al., 2008; Williams et al., 2012; de Graaf et al., 2013; Oza-Frank et al., 2014; Murphy, 2016; Vanden Broeck et al., 2016). Women and men of lower socioeconomic status might experience more and different barriers to receiving preconception care, including low health literacy, lack of child care or public transportation, lack of energy and time due to multiple competing demands, poor accessibility of preconception care services, lack of adequate finances, and poor coping strategies (Mazza and Chapman, 2010; Murphy et al., 2010; Zhu et al., 2012; Hogan et al., 2013; Squiers et al., 2013; Temel et al., 2013; Tuomainen et al., 2013; Atal and Cheng, 2016). These barriers pose an important challenge to overcome health disparities (differences in health by socioeconomic groups) as literature suggests that support programs are not powerful enough to overcome the barriers to use preconception care (Chen and Miller, 2013). Literature suggests that a community-based approach has the potential to reach women and men who are "hard-to-reach", including women and men of lower SES (Lassi et al., 2014; Shannon et al., 2014; van Voorst et al., 2015). For example, the recent meta-analysis of O'Mara-Eves et al. (2015) showed that community engagement interventions for disadvantaged groups are effective in terms of perceived social support, health behavior self-efficacy, health behaviors, and health consequences. Interventions engaging community members in the delivery of the intervention; involving peers, community members, and education professionals (compared with health professionals); and using skill development or training strategies (compared with educational strategies) tended to be the most effective for health behavior outcomes.

Interpersonal level

The interpersonal level includes formal and informal social networks and social support systems with others, such as partner, family, friends, and healthcare providers (Bronfenbrenner, 1979; McLeroy et al., 1988; Bartholomew et al., 2016).

The systematic review of Poels et al. (2016) identified several interpersonal factors influencing the use of preconception care. *Social support* was reported as a facilitator for the use of preconception care. Especially the partner's opinion seemed to be very important for women (Janz et al., 1995; Squiers et al., 2013; Temel et al., 2013; O'Higgins et al., 2014). By contrast, *social pressure* was an inhibiting factor for preconception care use (Murphy et al., 2010; Temel et al., 2013; Tuomainen et al., 2013; van der Zee et al., 2013). In addition, some specific *healthcare provider characteristics* were identified as factors influencing the decision to use

preconception care, including previous experiences with health services, communication issues, active offer of preconception care, and the healthcare provider's attitude (Janz et al., 1995; Mazza and Chapman, 2010; Murphy et al., 2010; Spence et al., 2010; Tuomainen et al., 2013; van der Zee et al., 2013; O'Higgins et al., 2014). This suggests that healthcare providers may have an important influence on women's and men's use of preconception care. To date, an overview of factors influencing the provision of preconception care by healthcare providers is lacking, and will be provided further in this thesis (chapter 8).

Organizational and community level

The organizational level includes social institutions with organizational characteristics, and formal and informal rules for operation, such as work settings, secondary schools, universities, primary care settings, and hospitals (Bronfenbrenner, 1979; McLeroy et al., 1988; Bartholomew et al., 2016). The community level includes relationships between organizations and informal networks within defined boundaries, such as a neighborhood, organizational relationships, and neighborhood organizations (Bronfenbrenner, 1979; McLeroy et al., 1988; Bartholomew et al., 2016).

Several organizational factors were identified as influencing factors on the use of preconception care. For example, the *access to preconception care services* was identified as an important influence on its uptake (Mazza and Chapman, 2010; Murphy et al., 2010; Zhu et al., 2012). Logistic concerns, including consultation hours during the office hours, travel issues, and lack of childcare might make hospital- or primary care based preconception care less accessible (Temel et al., 2013; Tuomainen et al., 2013; O'Higgins et al., 2014). In addition, limited *collaboration and referrals between healthcare providers* for preconception may hamper the use of preconception care (Poels et al., 2017a). Literature suggest that *schools* are important channels for endorsing preconception health and care (Edwards et al., 1997; Charron-Prochownik et al., 2006b; Delgado, 2008; Charafeddine et al., 2014; Lassi et al., 2014; Temel et al., 2015). However, integrating preconception health and care in existing sexual health education might be impeded by the fact that education systems are mainly focused on pregnancy prevention, and teachers' fear of promoting a teenage pregnancy (Vlaams Ministerie van Onderwijs en Vorming, 2010, 2017).

Societal level

The societal level includes social and cultural norms, national laws and policies, programs, and facilities of large political and geographic groups (Bronfenbrenner, 1979; McLeroy et al., 1988; Bartholomew et al., 2016).

There are several societal factors that can influence the use of preconception care. First, lack of *reimbursement* may impede the uptake and provision of preconception care (Schwarz et al., 2009; Ojukwu et al., 2016; Poels et al., 2016; M'hamdi et al., 2017). Another influencing societal factor is the *availability and access to educational materials for patients* (e.g. leaflets and websites) and *to professional resources* (e.g. evidence-based websites and tools) (Schwarz et al., 2009; Mortagy et al., 2010; Mazza et al., 2013; Stephenson et al., 2014). The availability of *national evidence-based guidelines* is also identified as an important factor that influences the provision of preconception care by healthcare providers (Heyes et al., 2004; Mortagy et al., 2010; Archibald et al., 2016; Poels et al., 2017a). In addition, *social and cultural norms* regarding the role of men during the (pre-)pregnancy period (i.e., pregnancy is still perceived as a "woman's domain"), and pregnancy planning (e.g., European Americans are more likely to consciously plan a pregnancy compared to African Americans) can also have an influence on the use of preconception care (Geronimus, 2003; Canady et al. 2008; World Health Organization, 2013; Widarsson et al., 2015).

The use of preconception care is only one preconception health behavior. Hardly any studies have been conducted on modifiable factors associated with other preconception health behaviors. The exceptions are studies on the use of folic acid in women (Temel et al., 2013) and studies investigating socio-demographic factors associated with preconception health behaviors (e.g. Stephenson et al., 2014; Bodin et al., 2017). In order to develop interventions to enhance preconception health behaviors, it would be interesting to investigate which modifiable factors are associated with different preconception health behaviors.

7. Preconception health and care in Flanders

7.1 Preconception health in Flanders

Little is known about preconception health in Flanders, Belgium. The Study Centre for Perinatal Epidemiology (SPE) is an independent and regionally funded center that registers 99.8% of all births of 500 gram and above. Although the SPE collects obstetric and perinatal data, few data is related to preconception health. Based on the SPE registrations of 54 022 singleton deliveries in 2009, a study of Bogaerts (2014) showed that almost one-third of women in Flanders are overweight (22%) or obese (10%) at the start of their pregnancy. The JOnG!-study of the Policy Research Centre for Welfare, Public Health and Family ('Steunpunt Welzijn, Volksgezondheid en Gezin') conducted research between 2008 and 2009 regarding the development, parenting, behavior, and health of Flemish newborns, with a sample of 2 106 mothers (Grietens et al., 2010). In total, 43% of the mothers took folic acid before becoming pregnant, and 23% smoked and 66% consumed

alcohol prior to the pregnancy (Hoppenbrouwers et al., 2010; Hoppenbrouwers et al., 2011a; Hoppenbrouwers et al., 2011b). The study of Vandevijvere et al. (2012) regarding the folate status in pregnant women in Belgium (n=1 311) showed that 41% and 22% of the women in their first and third trimester, respectively, reported taking folic acid supplements before their pregnancy. No distinction was made between data of Brussels, Wallonia, and Flanders (Vandevijvere et al., 2012). Data on pregnancy planning in Flanders are scarce. To the author's knowledge, only one study explored the prevalence of unplanned pregnancies in Flanders, the so-called SEXPERT study. The SEXPERT study was a large-scale study on sexual health in Flanders conducted between February 2011 and February 2012, and included 1 832 respondents aged 14 to 80 years (Buysse et al., 2013). In total, 25% of the respondents experienced at least one unplanned pregnancy between 2000 and 2011 (Buysse et al., 2013). The SEXPERT study measured pregnancy planning in a dichotomous manner (planned versus unplanned pregnancy). However, there is growing evidence for assessing pregnancy planning as a continuum to capture ambivalent feelings, attitudes and behaviors towards avoiding pregnancy, which is insufficiently captured in traditional, dichotomous instruments (Stanford et al., 2000; Santelli et al., 2003; Schwarz et al., 2007; Higgins et al., 2012).

7.2 Organization of preconception care in Flanders

7.2.1 Healthcare providers

In Flanders, obstetric care is provided by midwives, general practitioners, and gynecologists. Most pregnant women in Flanders choose the gynecologist to be their primary care provider during pregnancy, and will give birth at the hospital where their gynecologist practices (Emons and Luiten, 2001). Midwives are hardly involved in antenatal care, and often play an assisting role in the natal phase. Although little is known about their actual role during the preconception phase, midwives are legally able and competent to provide preconception care.

The Federal Council of Midwifes ('Federale Raad voor Vroedvrouwen') documented in 2016 the professional and competence profile of the Belgian midwife. The Belgian midwife was defined as a "healthcare provider that provides medical obstetric care during the preconception, pregnancy, labor, delivery, postpartum, and newborn period" (The Federal Council of Midwifes, 2016). Several competences of the midwives are related to preconception care, including competence 1 (advocacy for normal physiologic pregnancy, labor, and postpartum), competence 2 (risk assessment), and competence 5 (health promotion). Competence 1 of the midwife refers to the diagnosis, guidance, advocacy, and promotion of the normal physiological processes during the preconception, pregnancy, labor, delivery, postpartum, and newborn period; and specifically for preconception care: "the provision of a preconception consult" and "providing advice about family planning to

the woman and her partner". Competence 2 of the midwife refers to the autonomous detection of risks and complications, acting appropriately, consulting physicians and other healthcare providers, and referring appropriately; and specifically for preconception care: "to evaluate every situation and to detect potential risks and/or complications related to preconception, fertility, obstetrics, neonatology, and gynecology". Competence 5 refers to the provision of health promotion and prevention in a target-orientated manner according to the principles of health promotion, and specifically for preconception care: "to inform about fertility, sexuality, relationships, and preconception care" (The Federal Council of Midwifes, 2016).

The structure of the Flemish education profile of the Bachelor in midwifery is very similar to the professional and competence profile of the Belgian midwife (Flemish Education Council, 2014). The provision of preconception care is integrated in several competences: competence 1 (physiology, care and guidance), competence 2 (risk detection and risk selection), competence 4 (psychosocial context), and competence 6 (health promotion). One of the goals of competence 1 is the provision of a preconception consult in an autonomous manner. An overview of the knowledge and skills items that are essential to conduct a preconception consult are provided in Table 3. One of the goals of competence 2 is "to evaluate every situation and to detect potential risks and/or complications related to preconception, fertility, obstetrics, neonatology, and gynecology in an autonomous manner". No specific knowledge and skills items regarding preconception care are integrated in competence 2. In competence 4, one essential knowledge item and two essential kills are specifically related to preconception care (Table 3). One of the aims of competence 6 is "to sensitize youths to the importance of preventive reproductive healthcare, and to inform them about fertility, sexuality, relationships, and preconception care", with one knowledge and one skills item regarding preconception care (Table 3).

Table 3. Competences of Flemish education profile of the Bachelor in midwifery related to preconception care

COMPETENCE 1: PHYSIOLOGY, CARE AND GUIDANCE	
1.1 The provision of a preconception consult in an autonomous manner	
Knowledge	Skills
- Content of a preconception consult; - Menstrual cycle and factors that influence fertility; - Embryology; - Genetics and congenital risks, and screening and diagnostic tests; - Preimplantation genetic diagnosis.	- To conduct a preconception consult; - Counseling; - To conduct an anamnesis and complete an anamnesis questionnaire; - To evaluate the nutritional status and lifestyle; - To collect data, to observe, to interpret, to rapport, and to act adequately; - To order and/or perform relevant medical-obstetrical tests, to interpreter results, to rapport, and to act adequately; - To inform about the goal of a preconception consult

	and potential tests in an understandable way; - To support the woman and her partner in the choices regarding preconception screening.
COMPETENCE 4: PSYCHOSOCIAL CONTEXT	
4.1 To recognize and to respect the psychosocial unity of a woman, her family, and environment	
Knowledge	Skills
- Psychosocial aspects of sexuality and reproduction: (un)wanted sexual activity and (un)wanted pregnancy.	- To recognize and discuss psychosocial implications of preconception problems; - To guide and assist a woman and her partner with lifestyle changes.
COMPETENCE 6: HEALTH PROMOTION	
4.2 To sensitize youths to the importance of preventive reproductive healthcare, and to inform them about fertility, sexuality, relationships, and preconception care	
Knowledge	Skills
- Preventive and educational role of the midwife in avoiding complications during the preconception stage.	- To provide preconception care.

The department of midwifery of the Thomas More University College organizes a postgraduate course in preconception care for graduated midwives, general practitioners or other qualified healthcare providers (Thomas More University College, 2015). The total course counts 24 ECTS credits, and includes a basic module in preconception care, nursing sciences, prenatal tests and genetics, fertility, and a thesis.

7.2.2 Preconception care guidelines and recommendations

In Flanders, the only existing preconception care guidelines were developed in 2008 by 'Domus Medica' (Association of General Practitioners) (Samyn et al., 2008). The content of the preconception care guidelines include **(1) risk assessment** of medical conditions (asthma, diabetes mellitus, epilepsy, hypertension, thyroid disease, cardiovascular disease, deep venous thrombosis, chronic renal disease, cancer, and psychiatric conditions), infection diseases, family and genetic history, lifestyle and work environment (dietary pattern, body mass index, smoking, alcohol, drugs, work-related risks, hyperthermia), and medication use; **(2) blood analysis** to evaluate blood type, rubella, and toxoplasmosis status if unknown, and the **immunization** against rubella; and **(3)** the recommendation for **folic acid supplementation**. Although updated in 2011 (Samyn, 2011), these guidelines may be dated as evidence about preconception health and care is growing. Furthermore, the guidelines are focused on women only, and do not offer recommendations for men. In addition, these guidelines were mono-disciplinary developed by and for general practitioners, and thus, may be incomplete or not fully applicable or for other healthcare providers such as midwives.

The Superior Health Council of Belgium recommends to women planning a pregnancy to take 0.4 mg folic acid daily, starting from at least one month prior to pregnancy until at least 12 weeks after becoming pregnant. Women who are at high risk of having a baby with a neural tube defect are advised to take 4 mg per day (Superior Health Council of Belgium, 2016). There is no official policy regarding fortification of food with folic acid (Vandevijvere et al., 2012). The Superior Health Council of Belgium discourages folic acid food fortification due to the potential risks and side effects of a folic acid overdose, including masking a vitamin B12 deficiency and cancer (Superior Health Council of Belgium, 2011, 2016). However, some fortified products are available for consumption, such as cereal products and fruit juices (Superior Health Council of Belgium, 2011).

7.2.3 Reimbursement of preconception care

The Belgian healthcare system is based on a fee-for-service payment model with so-called 'nomenclature', which lists medical services that are fully or partially refunded by the health insurance (Van den Oever and Volckaert, 2008; Gerkens and Merkur, 2010). The provision of preconception care is not listed in the nomenclature. If a woman receives preconception care from a gynecologist or general practitioner, the healthcare provider can categorize it as a general consultation and the cost of this consult will be reimbursed. If a woman visits a midwife for preconception care, this care will not be refunded because midwifery care is only reimbursed in the context of a pregnancy, labor and birth, and postpartum care.

7.3 Preconception care interventions

In contrast to some neighboring countries such as the Netherlands (van der Zee et al., 2011), there is little experience in implementing preconception care initiatives in Flanders.

As part of the research line 'FREA' (Fertility and REproductive Awareness), a preconception consultation conducted by a midwife and gynecologist was implemented in 2010 in one university hospital in Flanders to assess which women attend a preconception consult and how they evaluate this preconception consult (Delbaere and De Sutter, 2011). Between January 2010 and March 2011, 74 women and couples had a preconception visit with a midwife. Most of the participants were relatively older (average age of 30 years), nulliparous (85%), married or cohabiting (99%), higher educated (85% had a bachelor's or higher degree), had the Belgian nationality (95%), and were not actively trying to conceive (58%). The majority of the participants had a healthy lifestyle (73% had a normal body mass index, 91% did not smoke), with exception of alcohol use (55% consumed alcohol). In addition, 34% of the women who were actively trying to conceive, did not use folic acid (Van Kerkhove, 2011; Delbaere, 2012). The majority of the women (97%) evaluated the preconception

consult as useful (Delbaere, 2012). The provision of this preconception visit was not continued after the project ended.

In 2011, the Flemish government released a public procurement on folic acid intake and preconception advice. One of the goals of this procurement was to develop an evidence-based website on preconception care, with a specific focus on folic acid intake (Delbaere et al., 2016). Between April 2013 and July 2014, the content of the website was developed. First, a literature review was conducted to identify existing guidelines on preconception and antenatal care. Next, the quality of the guidelines was assessed using the AGREE II. Subsequently, the topics of the website were selected by a panel of 5 internal experts and 16 external experts. Based on the final list of topics, evidence was selected from guidelines and reviews, and a first draft was written. Next, a multidisciplinary team of 40 experts in the field of women's and children's health were involved in the revision of the content of the website. A pilot study with a preliminary version of the website was carried out in a group of 30 first degree midwifery students and 6 people of reproductive age to assess the usability, comprehensibility, and the appealingness of the website. In February 2015, the final website 'www.gezondzwangerworden.be' was launched (In English: 'becoming pregnant in a healthy manner'). The website is in Dutch and consists of evidence-based information for both women and men planning a pregnancy, and healthcare providers. The website has a constant average of 100 – 200 visitors per day, mainly women (85%) and people aged 25 – 34 years (62%) (Delbaere et al., 2016).

OUTLINE AND OBJECTIVES

Since the CDC and March of Dimes released one of the first recommendations for preconception health and care in 2006, preconception health and care received increased scientific interest. Although growing interest, preconception health and care are still not fully implemented (Lassi et al., 2014). Compared to neighboring country The Netherlands, the organization and implementation of preconception care in Flanders is still in its infancy (van der Zee et al., 2011). One of the first steps in developing and implementing tailored strategies for improving preconception health and care is to conduct a needs assessment and a problem analysis to identify what needs to be changed (Bartholomew et al., 2016; World Health Organization, 2012). Therefore, the main objectives of the dissertation were (1) to gain insight into preconception needs, lifestyle changes, and its associated factors among reproductive-aged women and men, and (2) to investigate barriers and facilitators to the provision of preconception care by healthcare providers. These objectives resulted in six research questions.

1. What are the preconception-related information and support needs of women with a desire to have (more) children?
2. What are the psychometric properties of the Dutch version of the London Measure of Unplanned Pregnancy in women with pregnancies ending in birth?
3. What is the prevalence, and are associated factors and maternal and neonatal health outcomes of unplanned pregnancies ending in birth?
4. What are preconception lifestyle changes and associated factors in women with planned pregnancies ending in birth?
5. Which socio-demographic and psychosocial factors are associated with the intention to prepare for pregnancy in reproductive-aged women and men?
6. What are barriers and facilitators to the provision of preconception care by healthcare providers?

To the author's knowledge, no studies have assessed the preconception-related needs of reproductive-aged women. However, assessing the needs of the target population is one of the first steps of intervention development (Bartholomew et al., 2016; World Health Organization, 2012; Temel et al., 2015). Therefore, the preconception-related information and support needs were investigated among women with a desire to have (more) children (*objective 1*). Results of this study are presented in **chapter 2**.

Pregnancy planning is an important part of preconception health and care, because a couple has the opportunity to make lifestyle changes when the pregnancy is planned (Moos et al., 2008). Data on pregnancy

planning in Flanders are scarce. Therefore, it would be interesting to further investigate this. However, no national data registration or questionnaires are available for assessing the prevalence of unplanned pregnancies in Dutch-speaking regions. The 'London Measure of Unplanned Pregnancies' (LMUP) is a valid and reliable instrument to measure pregnancy planning. In **chapter 3**, the LMUP was translated from English into Dutch and its psychometric properties (validity and reliability) were evaluated (*objective 2*). In **chapter 4**, the Dutch version of the LMUP was used to assess the prevalence, associated factors, and health outcomes of unplanned pregnancies ending in birth (*objective 3*).

Planning a pregnancy is often a first and prerequisite step for preconception lifestyle changes. However, different studies found that women who are consciously planning a pregnancy do not always change their lifestyle before becoming pregnant. In order to gain insight in a broad range of preconception lifestyle changes and associated factors in women having a planned pregnancy, a secondary data analysis of the study about pregnancy planning was conducted in **chapter 5** (*objective 4*).

Another important part of intervention development is to understand which modifiable determinants are associated with preconception health behaviors or behavioral intentions (Bartholomew et al., 2016). To date, research on factors is limited to studies of socio-demographic factors associated with preconception health behaviors. Hardly any studies have been conducted on modifiable factors associated with preconception health behavior or behavioral intentions in the general population. Therefore, socio-demographic and psychosocial factors associated with the intention to prepare for pregnancy were investigated in women and men in **chapters 6 and 7**, respectively (*objective 5*).

Literature suggests that healthcare providers have an important influence on women's and men's use of preconception care (Poels et al., 2016). To date, an overview of influencing factors on the provision of preconception care is lacking. In **chapter 8**, a systematic review was conducted to assess the barriers and facilitators to the provision of preconception care by healthcare providers (*objective 6*).

Chapter 9 provides an overview of the key findings of this dissertation with recommendations for practice, future interventions, policy, education, and research.

An overview of the research objectives, research populations, and the methods employed in each study are presented in Table 4, and described in detail in the subsequent chapters of this dissertation.

Table 4. Overview of the studies and methods in each chapter of this dissertation

Chapter	Research objective	Research population	Methods
2	To investigate preconception information and support needs	Reproductive-aged women with a desire to have (more) children	Cross-sectional study - Sample: 242 women - Setting: 1 university hospital and online - Research instrument: questionnaire
3	To translate and investigate the psychometric properties of the Dutch version of the London Measure of Unplanned Pregnancy (LMUP)	Women with pregnancies ending in birth	Secondary data analysis of the study described in chapter 4 (n=517)
4	To investigate the prevalence, associated factors, and maternal and neonatal health outcomes of unplanned pregnancies ending in birth	Women with pregnancies ending in birth	Cross-sectional study - Sample: 517 women - Setting: 6 hospitals - Research instrument: questionnaire and medical records
5	To investigate preconception lifestyle changes and associated factors in women with planned pregnancies	Women with planned pregnancies ending in birth	Secondary data analysis of the study described in chapter 4 - Analytic sample: 430 women
6	To investigate socio-demographic and psychosocial factors associated with the intention to prepare for pregnancy in women	Reproductive-aged women with a desire to have (more) children	Cross-sectional study - Sample: 1722 women - Setting: 7 Community Health Centers, 4 Public Centers for Social Welfare, 1 youth welfare organization, 4 secondary schools, 1 private company, and online - Research instrument: questionnaire
7	To investigate socio-demographic and psychosocial factors associated with the intention to prepare for pregnancy in men	Reproductive-aged men with a desire to have (more) children	Cross-sectional study - Sample: 304 men - Setting: 7 Community Health Centers, 4 Public Centers for Social Welfare, 4 secondary schools, and online - Research instrument: questionnaire
8	To investigate barriers and facilitators to the provision of preconception care	Healthcare providers	A mixed-methods systematic review

References

Alkema L, Chou D, Hogan D, Zhang S, Moller A-B, Gemmill A, Fat DM, Boerma T, Temmerman M, Mathers C (2016) Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Maternal Mortality Estimation Inter-Agency Group. The Lancet 387:462-474.

Allaire AD, Cefalo RC (1998) Preconceptional health care model. Eur J Obstet Gynecol Reprod Biol 78:163-168.

Archibald AD, Hickerton CL, Wake SA, Jaques AM, Cohen J, Metcalfe SA (2016) "It gives them more options": preferences for preconception genetic carrier screening for fragile X syndrome in primary healthcare. Journal of community genetics 7:159-171.

Atal S, Cheng C (2016) Socioeconomic health disparities revisited: coping flexibility enhances health-related quality of life for individuals low in socioeconomic status. Health Qual Life Outcomes 14:7.

Atrash H, Jack BW, Johnson K (2008) Preconception care: a 2008 update. Curr Opin Obstet Gynecol 20:581-589.

Bartholomew Eldrigde LK, Markham CM, Ruiter RAC, Fernandez ME, Kok G, Parcel GS (2016) Planning health promotion programs: an intervention mapping approach, fourth Edition. Hoboken, NJ: Wiley & Sons.

Beurskens LW, Schrijver LH, Tibboel D, Wildhagen MF, Knapen MF, Lindemans J, de Vries J, Steegers-Theunissen RP (2013) Dietary vitamin A intake below the recommended daily intake during pregnancy and the risk of congenital diaphragmatic hernia in the offspring. Birth Defects Res A Clin Mol Teratol 97:60-66.

Bodin M, Kall L, Tyden T, Stern J, Drevin J, Larsson M (2017) Exploring men's pregnancy-planning behaviour and fertility knowledge:a survey among fathers in Sweden. Ups J Med Sci 122:127-135.

Bogaerts A (2014) Obesity and pregnancy, an epidemiological and intervention study from a psychosocial perspective. Facts, views & vision in ObGyn 6:81.

Bogaerts A, Van den Bergh BR, Ameye L, Witters I, Martens E, Timmerman D, Devlieger R (2013) Interpregnancy weight change and risk for adverse perinatal outcome. Obstet Gynecol 122:999-1009.

Botto LD, Krikov S, Carmichael SL, Munger RG, Shaw GM, Feldkamp ML (2016) Lower rate of selected congenital heart defects with better maternal diet quality: a population-based study. Arch Dis Child Fetal Neonatal Ed 101:F43-49.

Bronfenbrenner U (1979) The ecology of human development: Experiments by nature and design. American Psychologist 32:513-531.

Buysse A, Caen M, Dewaele A, Enzlin P, Lievens J, T'Sjoen G, Van Houtte M, Vermeersch H (2013) Seksuele gezondheid in Vlaanderen. Gent: Academia Press.

Canady RB, Tiedje LB, Lauber C (2008) Preconception care & pregnancy planning: voices of African American women. MCN Am J Matern Child Nurs 33:90-97.

Catalano PM, Shankar K (2017) Obesity and pregnancy: mechanisms of short term and long term adverse consequences for mother and child. Bmj 356:j1.

Centers for Disease Control and Prevention (2014) Preconception Health and Health Care. In: Centers for Disease Control and Prevention

Charafeddine L, El Rafei R, Azizi S, Sinno D, Alamiddine K, Howson CP, Walani SR, Ammar W, Nassar A, Yunis K (2014) Improving awareness of preconception health among adolescents: experience of a school-based intervention in Lebanon. BMC Public Health 14:774.

Charron-Prochownik D, Sereika SM, Wang SL, Hannan MF, Fischl AR, Stewart SH, Dean-McElhinny T (2006a) Reproductive health and preconception counseling awareness in adolescents with diabetes: what they don't know can hurt them. Diabetes Educ 32:235-242.

Charron-Prochownik D, Sereika SM, Falsetti D, Wang SL, Becker D, Jacober S, Mansfield J, White NH (2006b) Knowledge, attitudes and behaviors related to sexuality and family planning in adolescent women with and without diabetes. Pediatr Diabetes 7:267-273.

Chen E, Miller GE (2013) Socioeconomic status and health: mediating and moderating factors. Annu Rev Clin Psychol 9:723-749.

Coonrod DV, Jack BW, Boggess KA, Long R, Conry JA, Cox SN, Cefalo R, Hunter KD, Pizzica A, Dunlop AL (2008a) The clinical content of preconception care: immunizations as part of preconception care. Am J Obstet Gynecol 199:S290-295.

Coonrod DV, Jack BW, Stubblefield PG, Hollier LM, Boggess KA, Cefalo R, Cox SN, Dunlop AL, Hunter KD, Prasad MR, Lu MC, Conry JA, Gibbs RS, Hogan VK (2008b) The clinical content of preconception care: infectious diseases in preconception care. Am J Obstet Gynecol 199:S296-309.

Creanga AA, Berg CJ, Ko JY, Farr SL, Tong VT, Bruce FC, Callaghan WM (2014) Maternal mortality and morbidity in the United States: where are we now? J Womens Health (Larchmt) 23:3-9.

De-Regil LM, Fernandez-Gaxiola AC, Dowswell T, Pena-Rosas JP (2010) Effects and safety of periconceptional folate supplementation for preventing birth defects. Cochrane Database Syst Rev:Cd007950.

de Graaf JP, Steegers EA, Bonsel GJ (2013) Inequalities in perinatal and maternal health. Curr Opin Obstet Gynecol 25:98-108.

de Jong-Potjer LC, de Bock GH, Zaadstra BM, de Jong OR, Verloove-Vanhorick SP, Springer MP (2003) Women's interest in GP-initiated pre-conception counselling in The Netherlands. Fam Pract 20:142-146.

Dean SV, Lassi ZS, Imam AM, Bhutta ZA (2014) Preconception care: nutritional risks and interventions. Reprod Health 11 Suppl 3:S3.

Delbaere I (2012) The preconception consult: preparation, implementation, and research [In Dutch: De preconceptieraadpleging: voorbereiding, implementatie en onderzoek]. Congresdag Unie Vlaamse Vroedvrouwen.

Delbaere I, De Sutter P (2011) Fertility awareness and preconceptional counselling and care. In: European Society of Human Reproduction and Embryology (ESHRE). Stockholm, Sweden.

Delbaere I, Mokangi P, Roelens K, De Sutter A, Gellynck X, Beeckman D, van de Walle L, Vandenbulcke P, De Steur H (2016) Systematic development of an evidence-based website on preconception care. Ups J Med Sci:1-7.

Delgado CE (2008) Undergraduate student awareness of issues related to preconception health and pregnancy. Matern Child Health J 12:774-782.

Denny CH, Floyd RL, Green PP, Hayes DK (2012) Racial and ethnic disparities in preconception risk factors and preconception care. J Womens Health (Larchmt) 21:720-729.

Drieskens S, Gisle L (2015) Gebruik van gezondheids- en welzijnsdiensten. In: Gezondheidsenquete 2013. Brussel: Wetenschappelijk Instituut Volksgezondheid.

Duffy J, Rolph R, Gale C, Hirsch M, Khan KS, Ziebland S, McManus RJ (2017) Core outcome sets in women's and newborn health: a systematic review. Bjog 124:1481-1489.

Dunlop AL, Gardiner PM, Shellhaas CS, Menard MK, McDiarmid MA (2008a) The clinical content of preconception care: the use of medications and supplements among women of reproductive age. Am J Obstet Gynecol 199:S367-372.

Dunlop AL, Jack BW, Bottalico JN, Lu MC, James A, Shellhaas CS, Hallstrom LH, Solomon BD, Feero WG, Menard MK, Prasad MR (2008b) The clinical content of preconception care: women with chronic medical conditions. Am J Obstet Gynecol 199:S310-327.

Edwards G, Stanisstreet M, Boyes E (1997) Adolescents' ideas about the health of the fetus. Midwifery 13:17-23.

Egan AM, Smith V, Devane D, Dunne FP (2015) Effectiveness of prepregnancy care for women with pregestational diabetes mellitus: protocol for a systematic review of the literature and identification of a core outcomes set using a Delphi survey. Trials 16:356.

Egan AM, Galjaard S, Maresh MJA, Loeken MR, Napoli A, Anastasiou E, Noctor E, de Valk HW, van Poppel M, Todd M, Smith V, Devane D, Dunne FP (2017) A core outcome set for studies evaluating the effectiveness of prepregnancy care for women with pregestational diabetes. Diabetologia 60:1190-1196.

El-Ibiary SY, Raney EC, Moos MK (2014) The pharmacist's role in promoting preconception health. J Am Pharm Assoc (2003) 54:e288-301; quiz e301-283.

Elsinga J, van der Pal-de Bruin K, le Cessie S, de Jong-Potjer L, Verloove-Vanhorick S, Assendelft W (2006) Preconception counselling initiated by general practitioners in the Netherlands: reaching couples contemplating pregnancy [ISRCTN53942912]. BMC Fam Pract 7:41.

Emons J, Luiten M (2001) Midwifery in Europe: An inventory in fifteen EU-member states: Deloitte & Touche.

Erickson AC, Arbour LT (2012) Heavy smoking during pregnancy as a marker for other risk factors of adverse birth outcomes: a population-based study in British Columbia, Canada. BMC Public Health 12:102.

Feldkamp ML, Krikov S, Botto LD, Shaw GM, Carmichael SL (2014) Better diet quality before pregnancy is associated with reduced risk of gastroschisis in Hispanic women. J Nutr 144:1781-1786.

Feldkamp ML, Carmichael SL, Shaw GM, Panichello JD, Moore CA, Botto LD (2011) Maternal nutrition and gastroschisis: findings from the National Birth Defects Prevention Study. Am J Obstet Gynecol 204:404.e401-404.e410.

Ferreira da Costa F, Benedet J, Leal DB, Altenburg de Assis MA (2013) Clustering of risk factors for non communicable diseases in adults from Florianopolis, SC. Rev Bras Epidemiol 16:398-408.

Flemish Education Council (2014) Education Profile of Bachelor in Midwifery. In. Brussels: Flemish Education Council.

Floyd RL, Jack BW, Cefalo R, Atrash H, Mahoney J, Herron A, Husten C, Sokol RJ (2008) The clinical content of preconception care: alcohol, tobacco, and illicit drug exposures. Am J Obstet Gynecol 199:S333-339.

Frayne DJ, Verbiest S, Chelmow D, Clarke H, Dunlop A, Hosmer J, Menard MK, Moos MK, Ramos D, Stuebe A, Zephyrin L (2016) Health Care System Measures to Advance Preconception Wellness: Consensus Recommendations of the Clinical Workgroup of the National Preconception Health and Health Care Initiative. Obstet Gynecol 127:863-872.

Freda MC, Moos MK, Curtis M (2006) The history of preconception care: evolving guidelines and standards. Matern Child Health J 10:S43-52.

Frey KA, Files JA (2006) Preconception healthcare: what women know and believe. Matern Child Health J 10:S73-77.

Frey KA, Navarro SM, Kotelchuck M, Lu MC (2008) The clinical content of preconception care: preconception care for men. Am J Obstet Gynecol 199:S389-395.

Frieder A, Dunlop AL, Culpepper L, Bernstein PS (2008) The clinical content of preconception care: women with psychiatric conditions. Am J Obstet Gynecol 199:S328-332.

Gardiner PM, Nelson L, Shellhaas CS, Dunlop AL, Long R, Andrist S, Jack BW (2008) The clinical content of preconception care: nutrition and dietary supplements. Am J Obstet Gynecol 199:S345-356.

Garne E et al. (2012) Spectrum of congenital anomalies in pregnancies with pregestational diabetes. Birth Defects Res A Clin Mol Teratol 94:134-140.

Gerkens S, Merkur S (2010) Belgium: Health system review. Health systems in transition 12:1-266, xxv.

Geronimus AT (2003) Damned if you do: Culture, identity, privilege, and teenage childbearing in the United States. Soc Sci Med, 57: 881-893.

Gisle L (2014) Het gebruik van tabak. Brussel: WIV-ISP.

Gisle L, Demarest S (2014) Alcoholgebruik. Brussel: WIV-ISP.

Given JE, Loane M, Luteijn JM, Morris JK, de Jong van den Berg LT, Garne E, Addor MC, Barisic I, de Walle H, Gatt M, Klungsoyr K, Khoshnood B, Latos-Bielenska A, Nelen V, Neville AJ, O'Mahony M, Pierini A, Tucker D, Wiesel A, Dolk H (2016) EUROmediCAT signal detection: an evaluation of selected congenital anomaly-medication associations. Br J Clin Pharmacol 82:1094-1109.

Goossens J, Van Den Branden Y, Van der Sluys L, Delbaere I, Van Hecke A, Verhaeghe S, Beeckman D (2016) The prevalence of unplanned pregnancy ending in birth, associated factors, and health outcomes. Hum Reprod 31:2821-2833.

Grietens H, Hoppenbrouwers K, Desoete A, Wiersema R, Van Leeuwen K (2010) JOnG! Theoretische achtergronden, onderzoeksopzet en verloop van het eerste meetmoment. STEUNPUNT BELEIDSRELEVANT ONDERZOEK SWVG: FEITEN EN CIJFERS 11.

Groenen PM, van Rooij IA, Peer PG, Ocke MC, Zielhuis GA, Steegers-Theunissen RP (2004) Low maternal dietary intakes of iron, magnesium, and niacin are associated with spina bifida in the offspring. J Nutr 134:1516-1522.

Gunaïkeia (2015) Eén op de vijf Belgische vrouwen gaat nooit naar gynaecoloog. In.

Hacker NF, Gambone JC, Hobel CJ (2010) Hacker & Moore's Essentials of Obstetrics and Gynecology, 5 Edition. Philadelphia: Saunders.

Harelick L, Viola D, Tahara D (2011) Preconception health of low socioeconomic status women: assessing knowledge and behaviors. Womens Health Issues 21:272-276.

Heller CH and Clermont Y (1964) Kinetics of the germinal epithelium in man. Recent Prog Horm Res. 20: 545-575.

Heyes T, Long S, Mathers N (2004) Preconception care: practice and beliefs of primary care workers. Fam Pract 21:22-27.

Higgins JA, Popkin RA, Santelli JS (2012) Pregnancy ambivalence and contraceptive use among young adults in the United States. Perspectives on sexual and reproductive health 44:236-243.

Hirshberg A, Srinivas SK (2017) Epidemiology of maternal morbidity and mortality. Semin Perinatol.

Hogan VK, Culhane JF, Crews KJ, Mwaria CB, Rowley DL, Levenstein L, Mullings LP (2013) The impact of social disadvantage on preconception health, illness, and well-being: an intersectional analysis. Am J Health Promot 27:eS32-42.

Holroyd CR, Osmond C, Barker DJ, Ring SM, Lawlor DA, Tobias JH, Smith GD, Cooper C, Harvey NC (2016) Placental Size Is Associated Differentially With Postnatal Bone Size and Density. J Bone Miner Res 31:1855-1864.

Hood JR, Parker C, Atrash HK (2007) Recommendations to improve preconception health and health care: strategies for implementation. J Womens Health (Larchmt) 16:454-457.

Hoppenbrouwers K, Guérin C, Roelants M, Van Leeuwen K, Desoete A (2011a) Alcoholgebruik voor en tijdens de zwangerschap en in de periode van borstvoeding (SWVG Feiten & Cijfers 25).

Hoppenbrouwers K, Roelants M, Guérin C, Van Leeuwen K, Desoete A, Wiersema J (2010) Preventie van spina bifida en andere neuralebuisdefecten door foliumzuursuppletie tijdens dezwangerschap. SWVG Feiten en cijfers 3.

Hoppenbrouwers K, Roelants M, Guérin C, Van Leeuwen K, Desoete A, Wiersema J (2011b) Als mama rookt, rookt baby mee. Sociaaleconomische indicatoren en perinatale gezondheidseffecten van gedwongen blootstelling van een Vlaamse geboortecohorte aan tabaksrook tijdens de zwangerschap en in de eerste levensweken.

Hosli EJ, Elsinga J, Buitendijk SE, Assendelft WJ, van der Pal-de Bruin KM (2008) Women's motives for not participating in preconception counseling: qualitative study. Community Genet 11:166-170.

Huber JC, Jr., Brender JD, Zheng Q, Sharkey JR, Vuong AM, Shinde MU, Griesenbeck JS, Suarez L, Langlois PH, Canfield MA, Romitti PA, Weyer PJ (2013) Maternal dietary intake of nitrates, nitrites and nitrosamines and selected birth defects in offspring: a case-control study. Nutr J 12:34.

Hussein N, Kai J, Qureshi N (2016) The effects of preconception interventions on improving reproductive health and pregnancy outcomes in primary care: A systematic review. Eur J Gen Pract 22:42-52.

Jack BW, Culpepper L (1990) Preconception care. Risk reduction and health promotion in preparation for pregnancy. Jama 264:1147-1149.

Jack BW, Atrash H, Coonrod DV, Moos MK, O'Donnell J, Johnson K (2008) The clinical content of preconception care: an overview and preparation of this supplement. Am J Obstet Gynecol 199:S266-279.

Janz NK, Herman WH, Becker MP, Charron-Prochownik D, Shayna VL, Lesnick TG, Jacober SJ, Fachnie JD, Kruger DF, Sanfield JA, et al. (1995) Diabetes and pregnancy. Factors associated with seeking pre-conception care. Diabetes Care 18:157-165.

Johnson K, Posner SF, Biermann J, Cordero JF, Atrash HK, Parker CS, Boulet S, Curtis MG (2006) Recommendations to improve preconception health and health care--United States. A report of the CDC/ATSDR Preconception Care Work Group and the Select Panel on Preconception Care. MMWR Recomm Rep 55:1-23.

Karau SJ, Williams KD (1993) Social loafing: A meta-analytic review and theoretical integration. In: American Psychological Association.

Khan KS, Romero R (2014) The CROWN initiative: journal editors invite researchers to develop core outcomes in women's health. Am J Obstet Gynecol 211:575-576.

Klerman LV, Jack BW, Coonrod DV, Lu MC, Fry-Johnson YW, Johnson K (2008) The clinical content of preconception care: care of psychosocial stressors. Am J Obstet Gynecol 199:S362-366.

Korenbrot CC, Steinberg A, Bender C, Newberry S (2002) Preconception care: a systematic review. Matern Child Health J 6:75-88.

Lan L, Harrison CL, Misso M, Hill B, Teede HJ, Mol BW, Moran LJ (2017) Systematic review and meta-analysis of the impact of preconception lifestyle interventions on fertility, obstetric, fetal, anthropometric and metabolic outcomes in men and women. Hum Reprod 32:1925-1940.

Lassi ZS, Dean SV, Mallick D, Bhutta ZA (2014) Preconception care: delivery strategies and packages for care. Reprod Health 11 Suppl 3:S7.

Lind JN, Interrante JD, Ailes EC, Gilboa SM, Khan S, Frey MT, Dawson AL, Honein MA, Dowling NF, Razzaghi H, Creanga AA, Broussard CS (2017) Maternal Use of Opioids During Pregnancy and Congenital Malformations: A Systematic Review. Pediatrics 139.

Loane M, Dolk H, Greenlees R, Smith K, Addor MC, Barisic I, de Walle H, Bakker M, Garne E, Gatt M, Khoshnood B, Klungsoyr K, Nelen V, Neville AJ, O'Mahony M, Pierini A, Tucker D, Wiesel A (2017) Safety of Medication Use in Pregnancy in Relation to Risk of Congenital Malformations. In.

Lu MC, Highsmith K, de la Cruz D, Atrash HK (2015) Putting the "M" back in the Maternal and Child Health Bureau: reducing maternal mortality and morbidity. Matern Child Health J 19:1435-1439.

M'hamdi HI, van Voorst SF, Pinxten W, Hilhorst MT, Steegers EA (2017) Barriers in the uptake and delivery of preconception care: exploring the views of care providers. Maternal and child health journal 21:21-28.

Marchi J, Berg M, Dencker A, Olander EK, Begley C (2015) Risks associated with obesity in pregnancy, for the mother and baby: a systematic review of reviews. Obes Rev 16:621-638.

Mazza D, Chapman A (2010) Improving the uptake of preconception care and periconceptional folate supplementation: what do women think? BMC Public Health 10:786.

Mazza D, Chapman A, Michie S (2013) Barriers to the implementation of preconception care guidelines as perceived by general practitioners: a qualitative study. BMC Health Serv Res 13:36.

McDiarmid MA, Gardiner PM, Jack BW (2008) The clinical content of preconception care: environmental exposures. Am J Obstet Gynecol 199:S357-361.

McLeroy KR, Bibeau D, Steckler A, Glanz K (1988) An ecological perspective on health promotion programs. Health Educ Q 15:351-377.

Meader N, King K, Moe-Byrne T, Wright K, Graham H, Petticrew M, Power C, White M, Sowden AJ (2016) A systematic review on the clustering and co-occurrence of multiple risk behaviours. BMC Public Health 16:657.

Mitchell EW, Verbiest S (2013) Effective strategies for promoting preconception health--from research to practice. Am J Health Promot 27:S1-3.

Mitchell EW, Levis DM, Prue CE (2012) Preconception health: awareness, planning, and communication among a sample of US men and women. Matern Child Health J 16:31-39.

Moos MK (2010) From concept to practice: reflections on the preconception health agenda. J Womens Health (Larchmt) 19:561-567.

Moos MK, Cefalo RC (1987) Preconceptional health promotion: a focus for obstetric care. Am J Perinatol 4:63-67.

Moos MK, Dunlop AL, Jack BW, Nelson L, Coonrod DV, Long R, Boggess K, Gardiner PM (2008) Healthier women, healthier reproductive outcomes: recommendations for the routine care of all women of reproductive age. Am J Obstet Gynecol 199:S280-289.

Mortagy I, Kielmann K, Baldeweg SE, Modder J, Pierce MB (2010) Integrating preconception care for women with diabetes into primary care: a qualitative study. Br J Gen Pract 60:815-821.

Murphy HR (2016) Prepregnancy care: improvements for some women but not for all! Pol Arch Med Wewn 126:729-730.

Murphy HR, Temple RC, Ball VE, Roland JM, Steel S, Zill EHR, Simmons D, Royce LR, Skinner TC (2010) Personal experiences of women with diabetes who do not attend pre-pregnancy care. Diabet Med 27:92-100.

Nelen V, Coenen M, Den Hond E, Hermans A, Jacobs V, Thys G, Van de Mieroop E, Van Reempts P, Jacquemyn Y, van den Ende J (2017) Registratie van aangeboren afwijkingen: Eurocat Provincie Antwerpen: rapport 1989-2014. In.

Noble N, Paul C, Turon H, Oldmeadow C (2015) Which modifiable health risk behaviours are related? A systematic review of the clustering of Smoking, Nutrition, Alcohol and Physical activity ('SNAP') health risk factors. Preventive medicine 81:16-41.

O'Higgins S, McGuire BE, Mustafa E, Dunne F (2014) Barriers and facilitators to attending pre-pregnancy care services: the ATLANTIC-DIP experience. Diabet Med 31:366-374.

Ojukwu O, Patel D, Stephenson J, Howden B, Shawe J (2016) General practitioners' knowledge, attitudes and views of providing preconception care: a qualitative investigation. Upsala journal of medical sciences 121:256-263.

Opray N, Grivell RM, Deussen AR, Dodd JM (2015) Directed preconception health programs and interventions for improving pregnancy outcomes for women who are overweight or obese. Cochrane Database Syst Rev:Cd010932.

Ornoy A, Reece EA, Pavlinkova G, Kappen C, Miller RK (2015) Effect of maternal diabetes on the embryo, fetus, and children: congenital anomalies, genetic and epigenetic changes and developmental outcomes. Birth Defects Res C Embryo Today 105:53-72.

Osmond C, Barker DJ (2000) Fetal, infant, and childhood growth are predictors of coronary heart disease, diabetes, and hypertension in adult men and women. Environ Health Perspect 108 Suppl 3:545-553.

Oza-Frank R, Kachoria R, Keim SA, Klebanoff MA (2015) Provision of specific preconception care messages and associated maternal health behaviors before and during pregnancy. Am J Obstet Gynecol 212:372.e371-378.

Oza-Frank R, Gilson E, Keim SA, Lynch CD, Klebanoff MA (2014) Trends and factors associated with self-reported receipt of preconception care: PRAMS, 2004-2010. Birth 41:367-373.

Page RL, Padilla YC, Hamilton ER (2012) Psychosocial factors associated with patterns of smoking surrounding pregnancy in fragile families. Matern Child Health J 16:249-257.

Passey ME, Sanson-Fisher RW, D'Este CA, Stirling JM (2014) Tobacco, alcohol and cannabis use during pregnancy: clustering of risks. Drug Alcohol Depend 134:44-50.

Peterson C, Grosse SD, Li R, Sharma AJ, Razzaghi H, Herman WH, Gilboa SM (2015) Preventable health and cost burden of adverse birth outcomes associated with pregestational diabetes in the United States. Am J Obstet Gynecol 212:74.e71-79.

Poels M, Koster MP, Franx A, van Stel HF (2017a) Healthcare providers' views on the delivery of preconception care in a local community setting in the Netherlands. BMC Health Serv Res 17:92.

Poels M, Koster MPH, Franx A, van Stel HF (2017b) Parental perspectives on the awareness and delivery of preconception care. BMC Pregnancy Childbirth 17:324.

Poels M, van Stel HF, Franx A, Koster MPH (2017c) Actively preparing for pregnancy is associated with healthier lifestyle of women during the preconception period. Midwifery 50:228-234.

Poels M, Koster MP, Boeije HR, Franx A, van Stel HF (2016) Why Do Women Not Use Preconception Care? A Systematic Review On Barriers And Facilitators. Obstet Gynecol Surv 71:603-612.

Poels M, Lamain-de Rulter M, Van Stel HF, Kwee A, Bekker MN, Franx A, Koster MP (2017d) Modifiable lifestyle factors before and during early pregnancy and the risk of adverse pregnancy outcomes. submitted.

Poortinga W (2007) The prevalence and clustering of four major lifestyle risk factors in an English adult population. Preventive medicine 44:124-128.

Posner SF, Johnson K, Parker C, Atrash H, Biermann J (2006) The national summit on preconception care: a summary of concepts and recommendations. Matern Child Health J 10:S197-205.

Ramakrishnan U, Grant F, Goldenberg T, Zongrone A, Martorell R (2012) Effect of women's nutrition before and during early pregnancy on maternal and infant outcomes: a systematic review. Paediatr Perinat Epidemiol 26 Suppl 1:285-301.

Reefhuis J, De Walle H, Cornel MC (1998) Maternal smoking and deformities of the foot: results of the EUROCAT Study. European Registries of Congenital Anomalies. American journal of public health 88:1554-1555.

Rees S, Harding R, Walker D (2008) An adverse intrauterine environment: implications for injury and altered development of the brain. Int J Dev Neurosci 26:3-11.

Rosen MG, Merkatz IR, Hill JG (1991) Caring for our future: a report by the expert panel on the content of prenatal care. Obstet Gynecol 77:782-787.

Ruhl C, Moran B (2008) The clinical content of preconception care: preconception care for special populations. Am J Obstet Gynecol 199:S384-388.

Salihu HM, Salinas A, Mogos M (2013) The missing link in preconceptional care: the role of comparative effectiveness research. Matern Child Health J 17:776-782.

Samyn E (2011) Opvolgrapport. Aanbeveling voor goede medische praktijkvoering preconcetie advies. In: Domus Medica.

Samyn E, Bastiaens H, De Sutter A, Van Royen P (2008) Preconceptieadvies. 2008. In: Domus Medica.

Santelli J, Rochat R, Hatfield-Timajchy K, Gilbert BC, Curtis K, Cabral R, Hirsch JS, Schieve L (2003) The measurement and meaning of unintended pregnancy. Perspectives on sexual and reproductive health 35:94-101.

Schwarz EB, Lohr PA, Gold MA, Gerbert B (2007) Prevalence and correlates of ambivalence towards pregnancy among nonpregnant women. Contraception 75:305-310.

Schwarz EB, Santucci A, Borrero S, Akers AY, Nikolajski C, Gold MA (2009) Perspectives of primary care clinicians on teratogenic risk counseling. Birth Defects Research Part A: Clinical and Molecular Teratology 85:858-863.

Sedgh G, Singh S, Hussain R (2014) Intended and unintended pregnancies worldwide in 2012 and recent trends. Stud Fam Plann 45:301-314.

Shannon GD, Alberg C, Nacul L, Pashayan N (2013) Preconception health care and congenital disorders: mathematical modelling of the impact of a preconception care programme on congenital disorders. Bjog 120:555-566.

Shannon GD, Alberg C, Nacul L, Pashayan N (2014a) Preconception healthcare and congenital disorders: systematic review of the effectiveness of preconception care programs in the prevention of congenital disorders. Matern Child Health J 18:1354-1379.

Shannon GD, Alberg C, Nacul L, Pashayan N (2014b) Preconception healthcare delivery at a population level: construction of public health models of preconception care. Matern Child Health J 18:1512-1531.

Shih H-A, Susanto E (2016) Perceived identifiability, shared responsibility and innovative work behavior. The International Journal of Human Resource Management:1-19.

Smedts HP, Rakhshandehroo M, Verkleij-Hagoort AC, de Vries JH, Ottenkamp J, Steegers EA, Steegers-Theunissen RP (2008) Maternal intake of fat, riboflavin and nicotinamide and the risk of having offspring with congenital heart defects. Eur J Nutr 47:357-365.

Smith CJ, Ryckman KK (2015) Epigenetic and developmental influences on the risk of obesity, diabetes, and metabolic syndrome. Diabetes Metab Syndr Obes 8:295-302.

Solomon BD, Jack BW, Feero WG (2008) The clinical content of preconception care: genetics and genomics. Am J Obstet Gynecol 199:S340-344.

Spence M, Alderdice FA, Harper R, McCance DR, Holmes VA (2010) An exploration of knowledge and attitudes related to pre-pregnancy care in women with diabetes. Diabet Med 27:1385-1391.

Squiers L, Mitchell EW, Levis DM, Lynch M, Dolina S, Margolis M, Scales M, Kish-Doto J (2013) Consumers' perceptions of preconception health. American Journal of Health Promotion 27:S10-S19.

Stanford JB, Hobbs R, Jameson P, DeWitt MJ, Fischer RC (2000) Defining dimensions of pregnancy intendedness. Matern Child Health J 4:183-189.

Stanovich KE (1986) Matthew effects in reading: some consequences of individual differences in the acquisition of literacy. Reading Research Quarterly 21:160 - 406.

Steegers-Theunissen RP, Twigt J, Pestinger V, Sinclair KD (2013) The periconceptional period, reproduction and long-term health of offspring: the importance of one-carbon metabolism. Human reproduction update 19:640-655.

Stephenson J, Patel D, Barrett G, Howden B, Copas A, Ojukwu O, Pandya P, Shawe J (2014) How do women prepare for pregnancy? Preconception experiences of women attending antenatal services and views of health professionals. PLoS One 9:e103085.

Stothard KJ, Tennant PW, Bell R, Rankin J (2009) Maternal overweight and obesity and the risk of congenital anomalies: a systematic review and meta-analysis. Jama 301:636-650.

Stubblefield PG, Coonrod DV, Reddy UM, Sayegh R, Nicholson W, Rychlik DF, Jack BW (2008) The clinical content of preconception care: reproductive history. Am J Obstet Gynecol 199:S373-383.

Superior Health Council of Belgium (2011) Advice from Superior Health Council of Belgium: risk-benefit analysis of folic acid. In. Brussels: Superior Health Council of Belgium.

Superior Health Council of Belgium (2016) Nutritional recommendations for the Belgian population. In. Brussels: Superior Health Council of Belgium.

Temel S, van Voorst SF, Jack BW, Denktas S, Steegers EA (2014) Evidence-based preconceptional lifestyle interventions. Epidemiol Rev 36:19-30.

Temel S, Birnie E, Sonneveld HM, Voorham AJ, Bonsel GJ, Steegers EA, Denktas S (2013) Determinants of the intention of preconception care use: lessons from a multi-ethnic urban population in the Netherlands. Int J Public Health 58:295-304.

Temel S, van Voorst SF, de Jong-Potjer LC, Waelput AJ, Cornel MC, de Weerd SR, Denktas S, Steegers EA (2015) The Dutch national summit on preconception care: a summary of definitions, evidence and recommendations. J Community Genet 6:107-115.

The Federal Council of Midwifes (2016) The professional and competence profile of the Belgian midwife ('De beroeps- en competentieprofiel van de Belgische vroedvrouw'). In.

Thomas More University College (2015) Postgraduate Course in Preconception Care In.

Timmermans S, Bonsel GJ, Steegers-Theunissen RP, Mackenbach JP, Steyerberg EW, Raat H, Verbrugh HA, Tiemeier HW, Hofman A, Birnie E, Looman CW, Jaddoe VW, Steegers EA (2011) Individual accumulation of heterogeneous risks explains perinatal inequalities within deprived neighbourhoods. Eur J Epidemiol 26:165-180.

Toivonen KI, Oinonen KA, Duchene KM (2017) Preconception health behaviours: A scoping review. Preventive medicine 96:1-15.

Tuomainen H, Cross-Bardell L, Bhoday M, Qureshi N, Kai J (2013) Opportunities and challenges for enhancing preconception health in primary care: qualitative study with women from ethnically diverse communities. BMJ Open 3.

United Nations (2015a) Transforming our World: The 2030 Agenda for Sustainable Development In.

United Nations (2015b) The Millennium Development Goals Report 2015. In.

US Preventive Services Task Force (1996) Guide to clinical preventive services. Alexandria, VA: International Medical Publishing.

Van den Oever R, Volckaert C (2008) Financing Health Care in Belgium: The Nomenclature: from Fee-for-Service to Budget-Financing. Acta Chirurgica Belgica 108:157-166.

Van der Heyden J (2014) Chronische aandoeningen. Brussel: WIV-ISP.

van der Pal-de Bruin KM, le Cessie S, Elsinga J, de Jong-Potjer LC, van Haeringen A, Neven AK, Verloove-Vanhorick SP, Assendelft P (2008) Pre-conception counselling in primary care: prevalence of risk factors among couples contemplating pregnancy. Paediatr Perinat Epidemiol 22:280-287.

van der Zee B, de Beaufort ID, Steegers EA, Denktas S (2013) Perceptions of preconception counselling among women planning a pregnancy: a qualitative study. Fam Pract 30:341-346.

van der Zee B, de Beaufort I, Temel S, de Wert G, Denktas S, Steegers E (2011) Preconception care: an essential preventive strategy to improve children's and women's health. J Public Health Policy 32:367-379.

Vanden Broeck J, Feijen-de Jong E, Klomp T, Putman K, Beeckman K (2016) Antenatal care use in urban areas in two European countries: Predisposing, enabling and pregnancy-related factors in Belgium and the Netherlands. BMC Health Serv Res 16:337.

Vandevijvere S, Amsalkhir S, Van Oyen H, Moreno-Reyes R (2012) Determinants of folate status in pregnant women: results from a national cross-sectional survey in Belgium. Eur J Clin Nutr 66:1172-1177.

Van Kerkhove K (2011) Het profiel van vrouwen op de preconceptionele raadpleging [In Dutch: The profile of women attending a preconception consult]. Masterproef voorgelegd voor het behalen van de graad van Master in de Verpleeg-en Vroedkunde [Master thesis]. Available on https://www.scriptiebank.be/sites/default/files/a57d58693dcee77d86c730969cc3c685.pdf

Viteri OA, Soto EE, Bahado-Singh RO, Christensen CW, Chauhan SP, Sibai BM (2015) Fetal anomalies and long-term effects associated with substance abuse in pregnancy: a literature review. Am J Perinatol 32:405-416.

Vlaams Ministerie van Onderwijs en Vorming (2010) VOET@2010. Nieuwe vakoverschrijdende eindtermen voor het secundair onderwijs. In.

Vlaams Ministerie van Onderwijs en Vorming (2017) Onderwijs en vorming Vlaanderen. In.

Waelput AJM, Sijpkens MK, Lagendijk J, van Minde MRC, Raat H, Ernst-Smelt HE, de Kroon MLA, Rosman AN, Been JV, Bertens LCM, Steegers EAP (2017) Geographical differences in perinatal health and child welfare in the Netherlands: rationale for the healthy pregnancy 4 all-2 program. BMC Pregnancy Childbirth 17:254.

Wahabi HA, Alzeidan RA, Esmaeil SA (2012) Pre-pregnancy care for women with pre-gestational diabetes mellitus: a systematic review and meta-analysis. BMC Public Health 12:792.

Wahabi HA, Alzeidan RA, Bawazeer GA, Alansari LA, Esmaeil SA (2010) Preconception care for diabetic women for improving maternal and fetal outcomes: a systematic review and meta-analysis. BMC Pregnancy Childbirth 10:63.

Wallace M, Hurwitz B (1998) Preconception care: who needs it, who wants it, and how should it be provided? Br J Gen Pract 48:963-966.

Weightman AL, Morgan HE, Shepherd MA, Kitcher H, Roberts C, Dunstan FD (2012) Social inequality and infant health in the UK: systematic review and meta-analyses. BMJ Open 2.

Weijers-Poppelaars FA, Wildhagen MF, Henneman L, Cornel MC, Kate LP (2005) Preconception cystic fibrosis carrier screening: costs and consequences. Genet Test 9:158-166.

Weldon E, Gargano GM (1985) Cognitive effort in additive task groups: The effects of shared responsibility on the quality of multiattribute judgments. Organizational Behavior and Human Decision Processes 36:348-361.

Widarsson M, Engström G, Tydén T, Lundberg P, Hammar LM (2015) 'Paddling upstream': Fathers' involvement during pregnancy as described by expectant fathers and mothers. J Clin Nurs 24: 1059-1068.

Williams L, Zapata LB, D'Angelo DV, Harrison L, Morrow B (2012) Associations between preconception counseling and maternal behaviors before and during pregnancy. Matern Child Health J 16:1854-1861.

Williamson PR, Altman DG, Bagley H, Barnes KL, Blazeby JM, Brookes ST, Clarke M, Gargon E, Gorst S, Harman N, Kirkham JJ, McNair A, Prinsen CAC, Schmitt J, Terwee CB, Young B (2017) The COMET Handbook: version 1.0. Trials 18:280.

World Health Organization (2012) Meeting to Develop a Global Consensus on Preconception Care to Reduce Maternal and Childhood Mortality and Morbidity. In. Geneva: World Health Organization Headquarters.

Yi Y, Lindemann M, Colligs A, Snowball C (2011) Economic burden of neural tube defects and impact of prevention with folic acid: a literature review. Eur J Pediatr 170:1391-1400.

You D, Hug L, Ejdemyr S, Idele P, Hogan D, Mathers C, Gerland P, New JR, Alkema L (2015) Global, regional, and national levels and trends in under-5 mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Inter-agency Group for Child Mortality Estimation. The Lancet 386:2275-2286.

Zhu H, Graham D, Teh RW, Hornbuckle J (2012) Utilisation of preconception care in women with pregestational diabetes in Western Australia. Aust N Z J Obstet Gynaecol 52:593-596.

CHAPTER 2

PRECONCEPTION-RELATED NEEDS OF REPRODUCTIVE-AGED WOMEN

Based on the article of Goossens, J., Delbaere, I., Dhaenens, C., Willems, L., Van Hecke, A., Verhaeghe, S., Beeckman, D. (2016). Preconception-related needs of reproductive-aged women. Midwifery 33, 64 – 72. dio: 10.1016/j.midw.2015.10.012. Category NURSING: 13/114 (Q1) – IF: 1.948.

ABSTRACT

Objective: To asses women's interest in preconception care, their organizational preferences, and their preconception-related information and support needs.

Design: Cross-sectional study design.

Setting: Participants were recruited online through social media and discussion forums for issues relating to (in)fertility, pregnancy, and parenting; and in the Women's Clinic of Ghent University Hospital.

Participants: 242 reproductive-aged women with a desire to have (more) children.

Findings: The majority of women (75%) wanted to receive preconception care in the future. Gynecologists (93%) were the most preferred source for preconception care, followed by midwives (73%) and general practitioners (63%). Most women wanted information about lifestyle, environmental exposures, working conditions and medical issues. Information needs were higher among women with a (history of) mental illness [odds ratio (OR) 3.50, 95% confidence interval (CI) 1.08–11.36], a (history) of eye and otolaryngological problems (OR 2.22, 95% CI 0.95–5.21) and overweight (OR 2.22, 95% CI 1.01–4.93). A few women indicated that they needed preconception-related support. Overweight women reported greater need for lifestyle-related support compared with women of health weight (p=0.001).

Key conclusions: Reproductive-aged women are interested in preconception care, and would prefer to receive this care directly from a professional caregiver. Most women had high preconception-related information needs and lower support needs.

Implications for practice: Although women reported that they would prefer preconception care from gynecologists, the results indicate that midwives can also have an important role in the provision of preconception care. They would need further training to improve their knowledge, skills and awareness regarding preconception care.

Keywords: Preconception, Prepregnancy, Needs, Needs assessment, Information, Support

INTRODUCTION

Despite increased use of antenatal care services, reproductive outcomes remained stable over the last two decades (Johnson et al., 2006; Dimes, 2009). In Flanders (Belgium), the incidence of preterm birth, low birth weight and congenital malformations has stabilized; the number of children born with a birth weight below 2500 g was 6.9% in 1994, 6.9% in 2004 and 6.8% in 2013 (Cammu et al., 2005, 2014). The same trend can be observed concerning perinatal and maternal mortality. In Flanders (Belgium), the perinatal mortality was 8.1% in 1995, decreased to 6.7% in 2000, and subsequently stabilized (6.4% in 2013). Maternal mortality in Flanders

fluctuated slightly with a mortality rate of 1/15,000 in 2004 and 1/13,000 in 2013, with an overall average of one death in 19,000 women (Cammu et al., 2005, 2014).

Adverse reproductive outcomes can affect the child's health and quality of life during infancy, childhood and later on in life (Vermaes et al., 2005; Christianson et al., 2006; March Of Dimes Foundation, 2009; Jaddoe, 2014; Moreira et al., 2014). Moreover, adverse birth outcomes may have an impact on the mother's health. For example, adverse reproductive outcomes are associated with caesarean section, which increases the risk of maternal morbidity, including pain, reduced mobility, and infection (Liu et al., 2007; Haque et al., 2008; Kealy et al., 2010; Silver, 2012). Negative birth outcomes may also affect family life as some require psychosocial and family adjustments, and are associated with increased family costs and costs for society (Christianson et al., 2006). For example, the lifetime societal costs for spina bifida are estimated to be US$636,000 (€508.275), including costs for medical treatment, educational services and loss of productivity (Shannon et al., 2014).

Many adverse reproductive outcomes are associated with maternal and paternal risk factors that can be modified before conception through primary prevention (Johnson et al., 2006; Shannon et al., 2014; Corchia and Mastroiacovo, 2013). van der Pal-de Bruin et al. (2008) assessed the prevalence of risk factors with a potential influence on pregnancy outcome among 481 couples contemplating a pregnancy. The study revealed that all couples reported at least one risk factor for adverse pregnancy outcome which could be avoided by taking preventive measures.

The fetus is particularly vulnerable to environmental influences during organogenesis (days 17–56 postconception) (Hacker et al., 2010). Women often enter prenatal care or discover that they are pregnant when the fetal organs are already formed (Johnson et al., 2006; Atrash et al., 2008). Antenatal care is often too late to prevent adverse reproductive outcomes or birth defects, because these interventions take time to be effective (Atrash et al., 2006). For example, folic acid supplementation should start one month before conception to have an optimal effect on reducing the risk of neural tube defects (Wolff et al., 2009). A recent study of Shannon et al. (2014) estimated that between 585 and 1085 congenital disorders could be prevented with a national preventive care program. Thus, there is a need to act beyond the 'early diagnosis and management' approach and move into a 'primary prevention' one (Atrash et al., 2008).

Preconception care is a form of primary prevention and can be defined as 'the provision of biomedical, behavioral and social health interventions to women and couples before conception occurs' (World Health Organization, 2013). Key preconception care domains are family planning; tobacco, alcohol and other substance use; environmental exposures; genetics; infectious diseases and vaccination; medical conditions and medications; physical activity and nutrition; and psychosocial concerns (Atrash et al., 2006; Johnson et al., 2006; Posner et al., 2008). By reducing risk factors and improving the health status, women can have a

healthier pregnancy and a decreased risk for maternal and childhood mortality and morbidity (Atrash et al., 2008; World Health Organization, 2013).

Preconception care is not a new concept, but has been gaining momentum over the last two decades (Johnson et al., 2006; Atrash et al., 2008). Although preconception care has been recommended for many years, most health care professionals do not provide it and most women do not ask for it (Atrash et al., 2008). Little is known about women's reasons for not using preconception care. It is possible that women do not know that the first period of pregnancy is crucial, are unaware of their risk status, are unfamiliar with the concept of preconception care, or may not be interested in preconception care (de Jong-Potjer et al., 2003).

de Jong-Potjer et al. (2003) and Frey and Files (2006) explored the interest of women in preconception care. The results of de Jong-Potjer et al. (2003) indicated that regardless of age, more than 70% of women were interested in or would consider a preconceptional consultation when they decided to become pregnant. Only 11% of women stated specifically that they had no interest in preconception advice. Frey and Files (2006) found that 56% of women were interested and 10% might be interested in receiving preconception health education. The majority of women preferred to receive information from either a primary care physician (51%) or obstetrician/gynecologist (44%). The findings of both studies indicated that women are interested in preconception care, but did not provide insight into women's needs and preferences regarding this type of care. Although the study of Frey and Files (2006) assessed patient preferences for sources of preconception information, 'the midwife' was not an answer option in the survey.

To the authors' knowledge, no studies are available assessing preconception-related needs of reproductive-aged women extensively. However, assessing the needs of the target population is an important part of intervention development (Bartholomew et al., 2011). Interventions on preconception care must be tailored to the needs of a country and specific target groups within countries (Bartholomew et al., 2011; World Health Organization, 2013). One of the first steps in developing tailored interventions on preconception care is performing a needs assessment (World Health Organization, 2013). Therefore, this study aimed to explore women's interest in preconception care, their organizational preferences, and their preconception-related information and support needs. In addition, factors associated with interest in receiving preconception care, and preconception-related information and support needs were determined.

METHODS

Study design

A cross-sectional study design was chosen to gain insight into women's needs and preferences regarding preconception care. Preconception care in this study was defined as 'the provision of health information and/or guidance by professional caregivers or other sources in the period the conception occurs, with the aim to

improve maternal and child health outcomes'. The study was approved by the Ghent University Hospital Ethics Committee (B670201420381).

Sample

A convenience sample of women aged 18–40 years with a desire to have (more) children and fluent in Dutch were invited to participate in this study. No exclusion criteria were applied. Women were recruited at the Women's Clinic of Ghent University Hospital, and online through social media and discussion forums for issues relating to (in)fertility, pregnancy and parenting.

Data collection

Development of the needs assessment instrument

A needs assessment instrument was developed in accordance with the 'felt need' approach from Bradshaw (1972). Felt need refers to a patient's perceived need for help for a particular problem. Felt need is assessed by asking patients if they received sufficient help and if they would like to receive more help. This approach measures the 'real need' as defined by patients (Bradshaw, 1972; Johnsen et al., 2011).

The needs assessment instrument was developed based on the five stages described by Punch and Horner, 1991. The first stage involved an extensive literature review; and he second stage consisted of developing a conceptual framework. This framework was constructed based on the guidelines of the Centers for Disease Control and Prevention, and consisted of four key domains with several subdomains (Table 1) (Johnson et al., 2006).

Table 1. Conceptual framework of needs assessment instrument

Domain	Subdomains
Women's demographic and health profile	- Age - Nationality - Education - Occupation - Living situation - Marital status - Pregnancy plans - Health status (objective and subjective)
Organization of preconception care	- The receipt of preconception care in the past - The interest in receiving preconception care in the future - Preferred sources of preconception care - Interest in a preconception consultation
Preconception-related information	- Reproductive health and sexuality - Weight status, physical activity, nutrition - Folic acid - Infectious diseases - Immunization - Medical conditions: physical and mental disorders

	- Substance abuse (tobacco, alcohol, drugs) - Medications - Family medical and genetic history - Environmental exposures - Social and mental health
Preconception-related support	- Healthy weight, physical activity, nutrition - Medical conditions: physical and mental disorders - Substance abuse (tobacco, alcohol, drugs) - Family medical and genetic history - Social and mental health

The third stage involved generating items, scales and subscales. The development of items was based on research literature and existing questionnaires (Buziarsist et al., 2002; Frey and Files, 2006; Johnson et al., 2006; Atrash et al., 2008). The response options were based on the study of Johnsen et al. (2011) which assessed the 'felt need' of palliative patients with cancer. They were adapted to the concept of preconception care and consisted of four possible responses to assess the need for preconception-related information or support: (1) 'Yes, I am not informed/supported yet', (2) 'Yes, I am already partially informed/supported, but want more information/support', (3) 'No, I do not need this information/support', and (4) 'No, I am already fully informed/ the supporting care is completed'. The fourth stage involved an external review by experts and a pilot test. The items and overall scale were reviewed by a panel of 15 national experts (five general practitioners, four gynecologists, four Masters in midwifery and two independent midwives) to assess the content validity of the instrument (Polit and Beck, 2010). After the third round, the scale was judged to have excellent content validity with a content validity index of ≥ 0.78 (Polit and Beck, 2010). The next step comprised a pilot test with a small sample of 18 respondents (men and women) who were representative of the target population. Respondents were asked to provide feedback on the content, comprehensibility, and lay-out of the instrument. The pilot group consisted of 12 women and 6 men, and had a mean age of 28 years with a range of 21 to 34 years. Most of them had college or university education (n= 14). No immigrant people were included. The fifth stage consisted of finalizing the lay out of the instrument.

The final instrument contains five parts with 66 items (Supplementary data). The first part consists of demographic questions (seven items); the second part measures the medical history (seven items); the third part assesses the organizational preferences regarding preconception care (six items); the fourth part measures the need for preconception-related information (33 items), and the last part consists of 13 items assessing the need for preconception-related support (Table 1).

Procedure

Posters and flyers about the study were distributed in the waiting rooms of the Women's Clinic. Women who were interested in participating could receive information and the instrument at the registration desk. Women could complete the instrument while waiting for their appointment, and deposit it, together with the informed consent form, in a box at the registration desk. If they had not enough time to complete the instrument, they could take it home and send it to the research team using a prepaid envelope. The instrument was disseminated at the Women's Clinic between May and July 2014. The instrument was also available online and disseminated between March and June 2014 through discussion forums and social media.

Data analysis

Data were analyzed using Statistical Package for the Social Sciences Version 21 (IBM Corp., Armonk, NY, USA). $p < 0.05$ was considered to indicate significance. Categorical variables were presented as frequencies (percentages) and continuous variables were presented as means (ranges). Simple binary logistic regression analyses were performed to investigate the association between interest in receiving preconception care in the future and demographic, obstetric, and health and lifestyle characteristics. Independent variables with $p < 0.25$ were also entered in the multiple binary logistic regression; variables were removed from the model if they were not significant ($p < 0.10$) (Bursac et al., 2008). Odds ratios (OR) and 95% confidence intervals (CI) were calculated. A correlation analysis was performed to test for multicollinearity between the independent variables. Multicollinearity (Pearson's $r > 0.60$) was observed between the dichotomous variables 'parity' (been pregnant before versus never been pregnant) and 'reproductive and obstetric problems' (complicated versus normal obstetric anamnesis). Identical logistic regression analyses were performed on preconception information needs.

Responses to the information need items were dichotomized into 'information need' (response category 1 and 2) and 'no information need' (response category 3 and 4). The internal consistency for the information needs items was high with a Cronbach's Alpha of 0.92. A total information needs score was obtained by summing the recoded scores for the information needs items. The total information needs score was normally distributed (Skewness = -0.18, standard error = 0.18; kurtosis = -0.63, standard error = 0.36). This score was dichotomized by the mean score (14.6) to obtain a 'high information need' (≥ 14.7) and 'low information need' (≤ 14.6) group.

The responses to the preconception support need items were dichotomized in same manner as the information needs items. Due to the low internal consistency for the support needs items (Cronbach's Alpha = 0.54), no total score was calculated. The internal consistency for the following three support needs items was high (Cronbach's alpha = 0.78): 'obtaining a healthy weight', 'sufficient physical activity' and 'healthy nutrition'. A total 'lifestyle-related support needs' score was obtained by summing the recoded scores for these three

items. Chi-squared calculations were made to assess differences in lifestyle-related support needs. No inferential statistics were performed on the support needs due to low cell frequencies.

FINDINGS

Response rate and sample characteristics

In total, 263 women completed the instrument, of which 242 met the inclusion criteria. Most women completed the instrument online (214/242). The mean age of the respondents was 25.4 years [standard deviation (SD) 4.3]. Most women had a partner (86%), a higher level of education (77%) and were employed (59%). The majority of the women (87%) had no children and wanted children within three to five years (44%). Almost all women (93%) perceived their health as good or very good, did not smoke (82%) and did not use drugs (97%). Most women (81%) reported that they drank an average of three alcoholic drinks a week (SD 3.2). The majority of women (72%) had a normal weight (18.5 ≤ body mass index (BMI) < 25), whereas 5% were underweight (BMI < 18.5), 19% were overweight (25 ≤ BMI < 30) and 4% were obese (BMI ≥ 30). The number of women with a medical condition ranged between 1% and 34%, and the most commonly reported medical condition was allergy. Table 2 provides an overview of the demographic, obstetric, and health and lifestyle characteristics of the respondents.

Table 2. Participants' characteristics

Characteristic	**M**	**SD**	**Range**
Age (years, n=242)	25.4	4.3	18-40
BMI (kg/m², n=204)	23.2	3.8	15-43
Intake of alcohol among consumers (drinks/week, n=157)	3.2	3.2	0.5-25
Characteristic		**n**	**%**
Demographic characteristics			
Marital status (n=218)			
Married or living with partner		91	42
Have a partner but do not live together		96	44
Single		30	14
Divorced		1	0
Education (n=215)			
Master degree		47	22
Bachelor degree		118	55
Post-secondary degree		12	6
Higher secondary degree		35	16
Lower secondary degree		3	1
Employment (n=217)			
Employed (full-time or part-time)		127	59
Student		76	35
Jobseeker		2	1
Housewife		3	1
Living wage		1	1
Other		8	3

Characteristic		n	%
Nationality (n=242)			
Belgian		224	93
Other		18	7
Obstetric characteristics			
Pregnancy history (n=205)			
Gravida ≥ 1		40	20
Para > 0		27	13
Miscarriage		17	8
Abortus provocates		6	3
Desire for children (n=223)			
Active		51	23
Within 2 years		43	19
Within 3-5 years		98	44
No concrete plans		31	14
Health and lifestyle characteristics			
Subjective health (n=219)			
Very good		52	24
Good		151	69
Average		15	7
Poor		1	0
Very poor		0	0
Smoking (n=205)			
Never smoker		138	67
Former smoker		31	15
Less than daily smoker		13	6
Daily smoker		23	11
Alcohol (n=205)			
Never consumed		16	8
Former consumer		23	11
Consumer		166	81
Drugs (n=205)			
Never used		192	94
Former user		7	3
User		6	3
Medical conditions			
Cardiovascular (n=207)		22	11
Musculoskeletal (n=206)		36	18
Dermatological (n=207)		37	18
Endocrinal (n=204)		24	12
Mental (n=208)		21	10
Respiratory (n=208)		15	7
Gastrointestinal (n=208)		18	9
Infectious and parasitic (n=208)		21	10
Eye and otolaryngological (n=208)		40	19
Urinary (n=208)		14	7
Allergies (n=208)		71	34
Sexual and breast (n=208)		30	12
Reproductive and obstetric (n=208)		23	11
Congenital and hereditary (n=208)		3	1
Other (n=208)		10	4

BMI, body mass index; SD, standard deviation.

Organization of preconception care

Receipt and interest in preconception care

One-third of the participants (34%, n = 67) had received preconception care in the past. Eighty-one percent (n = 54) of these women had received preconception care from a professional, including gynecologists (82%), general practitioners (43%), midwives (20%) and/or medical specialists (11%) (Fig. 1). Other sources of preconception information are presented in Fig. 1. The majority of the women (75%, n = 148) reported that they wished to receive preconception care in the future, and most wanted to receive it directly from a professional caregiver (93%). Gynecologists (93%) were the preferred source for preconception care, followed by midwives (73%) and general practitioners (63%) (Table 3).

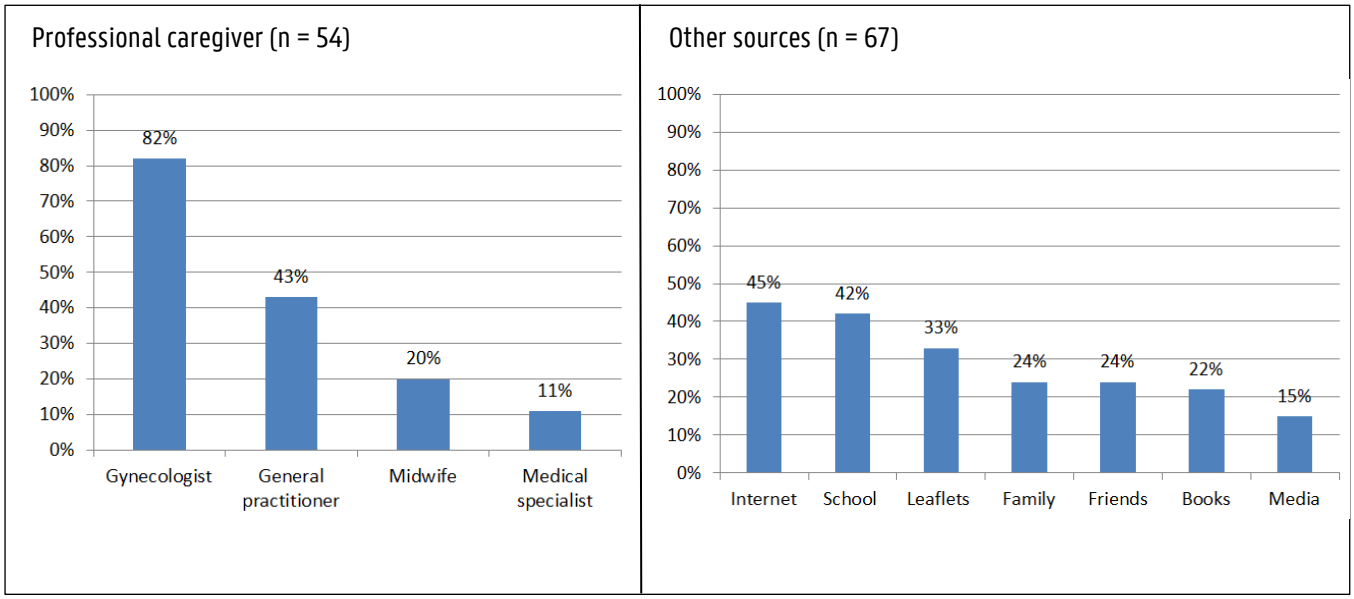


Figure 1. Sources of preconception care

Table 3. Preferred sources of preconception care

Information source	n	%*
Professional caregiver	138	93
Gynecologist	138	93
Midwife	108	73
General practitioner	93	63
Leaflets	80	54
Internet	74	50
Books	35	24

*Percentages add to more than 100 as women could identify more than one preferred source.

Interest in a preconception consultation

Eighty-seven percent (n = 116) of the women who reported that they would like to receive preconception care in the future were also interested in a preconception consultation with a professional caregiver. Two-thirds (67%) of these women indicated that they would like to have multiple consultations to explore certain topics and monitor their health.

Factors associated with interest in receiving preconception care in the future

The simple regression analysis (Table 4) showed that lack of history of reproductive and obstetric problems (p = 0.03) and high information needs (p < 0.01) were significantly associated with interest in receiving preconception care in the future. In the multiple analysis, underweight or normal weight [OR 2.97, 95% CI 1.14–7.72) and high information needs (OR 1.18, 95% CI 1.11–1.26) were independently associated with interest in receiving preconception care in the future (Table 5).

Table 4. Simple binary logistic regression with the interest in receiving preconception care in the future as dependent variable

Variables	OR	95% CI	P value
Demographic characteristics			
Age°	0.95	0.88-1.02	0.14
Single or divorced*	1.12	0.47-2.66	0.80
Education~	0.99	0.72-1.35	0.93
Non-employed†	1.11	0.57-2.16	0.75
Non-Belgian§	0.35	0.12-1.02	0.06
Obstetric characteristics			
Never been pregnant¶	2.00	0.94-4.28	0.07
No children‡	1.68	0.52-5.46	0.39
Miscarriage#	1.64	0.47-5.79	0.44
No active desire for children**	1.13	0.54-2.37	0.74
Health and lifestyle characteristics			
Suboptimal subjective health††	1.38	0.37-5.11	0.63
Smoking#	0.88	0.38-2.05	0.77
Alcohol#	1.65	0.77-3.53	0.20
Drugs#	1.71	0.20-15.03	0.63
Overweight or obesity (BMI ≥ 25 kg/m²)§§	0.59	0.26-1.31	0.20
Cardiovascular problems#	1.10	0.38-3.17	0.86
Musculoskeletal problems#	2.16	0.79-5.94	0.14
Dermatological problems#	2.05	0.75-5.65	0.16
Endocrinal problems#	0.98	0.37-2.64	0.98
Mental illness#	0.77	0.28-2.12	0.61
Respiratory problems#	0.73	0.25-2.79	0.77
Gastrointestinal problems#	1.77	0.49-6.38	0.39
Infectious and parasitic diseases#	3.54	0.78-15.75	0.10
Eye and otolaryngological problems#	1.34	0.57-3.14	0.51
Urinary problems#	4.72	0.60-37.02	0.14

Variables	OR	95% CI	P value
Allergies[#]	1.26	0.63-2.53	0.51
Sexual and breast problems[#]	2.45	0.81-7.41	0.11
Reproductive and obstetric problems[#]	0.35	0.14-0.88	0.03
Received preconception care[¶¶]	0.70	0.36-0.70	0.29
Information needs	1.16	1.09-1.22	< 0.01
Support needs			
Lifestyle-related[#]	0.91	0.23-3.64	0.89
Medical-related[#]	1.81	0.21-15.29	0.59
Mental-related[#]	0.56	0.14-2.32	0.43
Financial-related[#]	0.74	0.14-3.88	0.73

OR = odds ratio; CI = confidence interval; °continuous variable; *Married or living with partner/have a partner but do not live together is reference category compared with single/divorced; ^ordinal variable: none=1; primary education=2; lower secondary degree=3; higher secondary degree=4; post-secondary degree=5; bachelor degree=6; master degree=7; †Employed is the reference category compared with student/jobseeker/home duties/living wage; §Belgian is reference category; ¶Been pregnant before is reference category compared with never been pregnant; ǂHaving children is reference category compared with no children; #Absence of disease, medical problem or risky behavior is reference category compared with presence of disease, medical problem or risky behavior; **Active desire for children is reference category compared with desire for children within 2 years/ 3–5 years/no concrete plans; ††Good/very good is reference category compared with average/poor/very poor; §§ Underweight/healthy weight (BMI < 25 kg/m²) is reference category compared with overweight/obesity (BMI ≥ 25 kg/m²); ¶¶ Received preconception care before is reference category compared with never received before; [#] Low need is reference category compared with high need.

Table 5. Multiple binary logistic regression with the interest in receiving preconception care in the future as dependent variable

Variable	OR	95% CI	P value
Underweight or healthy weight (BMI < 25 kg/m²)*	2.97	1.14-7.72	0.03
Information needs	1.18	1.11-1.26	< 0.01

OR = odds ratio; CI = confidence interval; *Overweight/obesity (BMI ≥ 25 kg/m²) is reference category compared with underweight/healthy weight (BMI < 25 kg/m²).

Preconception-related information needs

Topics about which women wanted information

Most women wanted information about nutrition (82%) and nutritional supplements (73%). The majority also wanted information about the influence of working conditions (80%), sports and leisure (79%), vaccination (77%), environmental conditions (76%), infectious diseases (74%) and medication (71%) on fertility and pregnancy. Information needs were low regarding smoking and secondhand smoke (21%), alcohol (21%), sexuality and fertility (20%), sexual transmitted diseases (15%), domestic violence (8%), and drugs (7%). Table 6 provides an overview of the preconception-related information needs per topic.

Table 6. Preconception-related information needs

Topic	I want information n (%)		I do not want information n (%)	
	Not informed yet	*Partially informed*	*No need for information*	*Fully informed*
Nutrition	58 (32%)	90 (50%)	7 (4%)	24 (13%)
Working conditions	82 (44%)	66 (36%)	19 (10%)	19 (10%)
Sports and leisure	66 (37%)	75 (42%)	22 (12%)	16 (9%)
Vaccinations	59 (35%)	71 (42%)	15 (9%)	26 (15%)
Environmental exposures	80 (43%)	61 (33%)	28 (15%)	17 (9%)
Infectious diseases	47 (28%)	78 (46%)	15 (9%)	31 (18%)
Nutritional supplements	53 (30%)	77 (43%)	15 (8%)	34 (19%)
Medications	49 (29%)	71 (42%)	32 (19%)	19 (11%)
Family medical and genetic history	45 (26%)	54 (32%)	40 (23%)	32 (19%)
Medical conditions	44 (26%)	47 (28%)	50 (29%)	30 (18%)
Influence pregnancy on medical conditions	46 (27%)	34 (20%)	66 (39%)	25 (15%)
Obstetric complications	34 (21%)	39 (24%)	64 (39%)	28 (17%)
Mental illness	38 (22%)	28 (16%)	85 (50%)	20 (12%)
Influence pregnancy on mental disorders	33 (19%)	29 (17%)	87 (51%)	22 (13%)
Physical activity	10 (6%)	48 (27%)	42 (24%)	79 (44%)
Financial matters	35 (25%)	15 (11%)	64 (47%)	23 (17%)
Healthy weight	13 (7%)	45 (25%)	49 (27%)	72 (40%)
Increasing pregnancy chances	15 (9%)	56 (34%)	25 (15%)	69 (42%)
Smoking and secondhand smoke	9 (5%)	29 (16%)	49 (27%)	92 (51%)
Alcohol	10 (6%)	27 (15%)	42 (24%)	100 (56%)
Sexuality and fertility	4 (2%)	30 (18%)	45 (27%)	86 (52%)
Sexual transmitted diseases	4 (2%)	21 (13%)	53 (32%)	87 (53%)
Domestic violence	8 (5%)	5 (3%)	118 (74%)	28 (18%)
Drugs	4 (2%)	8 (5%)	70 (39%)	97 (54%)

Factors associated independently with preconception-related information needs

The simple logistic regression analysis (Table 7) showed that having (history of) a mental illness (p = 0.03) or (a history) eye or otolaryngological problems (p = 0.02) were significantly associated with a high preconception-related information needs. In the multiple analysis, being overweight (OR 2.22, 95% CI 1.01–4.93), (history of) mental illness (OR 3.50, 95% CI 1.08–11.36) and (history of) eye or otolaryngological problems (OR 2.22, 95% CI 0.95–5.21) were independently associated with high information need (Table 8).

Table 7. Simple binary logistic regression with high information need (≥ 14.7) as the dependent variable

Variables	OR	95% CI	P value
Demographic characteristics			
Age°	1.00	0.94-1.07	0.96
Single or divorced*	1.27	0.58-2.76	0.56
Education^	1.06	0.80-1.40	0.69
Non-employed†	0.88	0.49-1.59	0.67
Non-Belgian§	1.01	0.35-2.89	0.99
Obstetric characteristics			
Never been pregnant¶	1.78	0.85-3.72	0.12
No children‡	3.11	0.94-10.25	0.06
Miscarriage#	2.64	0.76-9.15	0.13
No active desire for children**	1.49	0.77-2.89	0.24
Health and lifestyle characteristics			
Suboptimal subjective health††	3.50	0.94-12.99	0.06
Smoking#	0.93	0.43-2.00	0.84
Alcohol#	1.44	0.70-2.97	0.32
Drugs#	2.69	0.27-26.32	0.40
Overweight or obesity (BMI ≥ 25 kg/m²)§§	2.02	0.93-4.38	0.08
Cardiovascular problems#	0.54	0.21-1.40	0.20
Musculoskeletal problems#	1.54	0.70-3.37	0.28
Dermatological problems#	1.16	0.53-2.56	0.71
Endocrinal problems#	1.90	0.77-4.70	0.16
Mental illness#	3.71	1.18-11.63	0.03
Respiratory problems#	0.71	0.21-2.44	0.60
Gastrointestinal problems#	1.28	0.47-3.53	0.63
Infectious and parasitic diseases#	0.97	0.38-2.52	0.96
Eye and otolaryngological problems#	2.60	1.17-5.79	0.02
Urinary problems#	2.08	0.62-6.99	0.24
Allergies#	0.87	0.50-1.60	0.65
Sexual and breast problems#	1.10	0.50-2.43	0.82
Reproductive and obstetric problems#	0.43	0.16-1.14	0.09
Congenital and hereditary problems#	0.89	0.06-14.41	0.93
Other problems#	0.83	0.43-12.10	0.33
Received preconception care¶¶	1.28	0.69-2.35	0.43
Support needs			
Lifestyle-related#	0.73	0.23-2.83	0.73
Smoking cessation#	0.25	0.05-1.19	0.08
Medical-related	0.81	0.19-3.53	0.78
Mental-related#	0.14	0.02-1.13	0.06
Financial-related#	0.44	0.09-2.25	0.32

OR = odds ratio; CI = confidence interval; °continuous variable; *Married or living with partner/have a partner but do not live together is reference category compared with single/divorced; ^^ordinal variable: none=1; primary education=2; lower secondary degree=3; higher secondary degree=4; post-secondary degree=5; bachelor degree=6; master degree=7; †Employed is the reference category compared with student/jobseeker/home duties/living wage; §Belgian is reference category; ¶Been pregnant before is reference category compared with never been pregnant; ‡ Having children is reference category compared with no children; #Absence of disease, medical problem or risky behavior is reference category compared with presence of disease, medical problem or risky behavior; **Active desire for children is reference category compared with desire for children within 2 years/3-5 years/no concrete plans; ††Good/very good is reference category compared with average/poor/very poor; §§ Underweight/healthy weight (BMI < 25 kg/m²) is reference category compared with overweight/obesity (BMI ≥ 25 kg/m²); ¶¶ Received preconception care before is reference category compared with never received before; # Low need is reference category compared with high need.

Table 8. Multiple binary logistic regression with high information need (≥ 14.7) as the dependent variable

Variable	OR	95% CI	P value
Overweight or obesity (BMI ≥ 25 kg/m²)*	2.22	1.01-4.93	0.05
Mental illness#	3.50	1.08-11.36	0.04
Eye and otolaryngological problems#	2.22	0.95-5.21	0.07

OR = odds ratio; CI = confidence interval; * Underweight/healthy weight (BMI < 25 kg/m²) is reference category compared with overweight/obesity (BMI ≥ 25 kg/m²); # Absence of disease, medical problem or risky behavior is reference category compared with presence of disease, medical problem or risky behavior.

Preconception-related support needs

Topics in which women wanted support

The highest preconception-related support needs were regarding nutrition (25%), obtaining a healthy weight (22%) and becoming physical active (21%). Support needs were low for drug cessation (1%), domestic violence (0%) and alcohol cessation (0%). An overview of preconception-related support needs is presented in Table 9.

Table 9. Preconception-related support needs

Topic	I want support n (%)		I do not want support n (%)	
	Not supported yet	*Partially supported*	*No need to be supported*	*Supporting care completed*
Nutrition	24 (16%)	14 (9%)	112 (73%)	4 (3%)
Healthy weight	23 (15%)	12 (8%)	111 (72%)	8 (5%)
Physical activity	22 (14%)	11 (7%)	114 (74%)	7 (5%)
Family medical and genetic history	17 (11%)	4 (3%)	131 (85%)	2 (1%)
Smoking cessation	10 (7%)	2 (1%)	139 (90%)	3 (2%)
Medical conditions	4 (3%)	4 (3%)	140 (91%)	6 (4%)
Mental illness	5 (3%)	5 (3%)	135 (88%)	9 (6%)
Obstetric complications	4 (3%)	3 (2%)	143 (93%)	4 (3%)
Financial matters	8 (5%)	0 (0%)	144 (94%)	2 (1%)
Drug cessation	1 (1%)	0 (0%)	149 (97%)	4 (3%)
Domestic violence	0 (0%)	0 (0%)	151 (98%)	3 (2%)
Alcohol cessation	0 (0%)	0 (0%)	151 (99%)	2 (1%)

Factors associated with lifestyle-related support needs

Being overweight was significantly associated with lifestyle-related support needs. Overweight women reported greater need for lifestyle support compared with women of healthy weight (81% versus 19%; p = 0.001). Age, education, employment, marital status, having children, desire for children, subjective health, smoking, drinking alcohol, drug abuse and having a (history of) mental illness or medical condition were not significantly associated with lifestyle-related support needs.

DISCUSSION

The aim of this study was to assess women's preconception-related needs and preferences, and to determine associated factors with interest in receiving preconception care and preconception-related needs. To the authors' knowledge, this is the first study to extensively explore the needs and preferences of reproductive-aged women regarding preconception care.

The majority of the women (75%) wanted to receive preconception care in the future. This is higher in comparison with the findings of Frey and Files (2006), who found that 56% of women were interested in receiving preconception health education. The difference may be attributed to the fact that women in the current study could only answer 'yes' or 'no' to the question about whether or not they wanted to receive preconception health education in the future. The study of Frey and Files (2006) added an additional answer option 'unsure'. If one compares the overall score of women who indicated that they were interested or might be interested in preconception care with the present results, the findings are comparable.

Half of the women (48%) in the present study were interested in a preconception consultation. This is lower in comparison with the study findings of de Jong-Potjer et al. (2003), who found that 57% were interested and 15% might be interested in preconception counseling. These differences can be explained, in part, by the selection of the study population. In the study de Jong-Potjer et al. (2003), women received a letter from their own general practitioner offering preconception counseling. A personal invitation might arouse interest, whereas the sample in the present study was self-selected.

Most women (93%) indicated that they would like to receive preconception care directly from a professional caregiver. Gynecologists (93%) were the preferred source for preconception care, followed by midwives (73%) and general practitioners (63%). Frey and Files (2006) also found that the majority of women would prefer to receive preconception-related information from a physician, with either a primary care physician (51%) or obstetrician/gynecologist (44%) as first preference. 'Midwife' was not included in the list of answer options. In Australia, Grimes et al. (2014) assessed the most useful sources of information for pregnant women. Books (17.2%), midwives (15.7%) and the Internet (15.1%) were rated to be the three most useful sources. General practitioners and obstetricians were placed ninth and tenth. Cultural and organizational differences between Belgium and Australia in terms of preconception and antenatal care can explain these findings. In Australia, many women are referred to a public hospital (71%), where pregnancy care for women with low-risk pregnancies is usually provided by midwives (Queensland Centre for Mothers and Babies, 2010; Department of Health, 2012; Li et al., 2013). Only women with an increased risk for pregnancy complications are being referred to obstetricians/gynecologists (Queensland Centre for Mothers and Babies, 2010; Department of Health, 2012).

In Belgium, routine (pre-) pregnancy care for women is mostly provided by obstetricians/gynecologists, regardless of the woman's risk status (Emons and Luiten, 2001). A difference in model of care could explain why most Belgian women prefer to receive information from their gynecologists instead of midwives; and why Australian women prefer to receive information from their midwives instead of general practitioners or gynecologists.

Only half of the women in this study indicated that they would prefer to receive preconception care via the Internet. The Internet is a widely used source of health information for men and women of reproductive age, including those who want to conceive or are already pregnant. Many pregnant women often use the Internet to find pregnancy-related information (Lagan et al., 2006, 2010; Larsson, 2009; Lima-Pereira et al., 2012). Although the Internet is often used as a source of information, this does not necessary mean that it is the preferred source (Dolan et al., 2004). An individual consultation with a health care professional provides the opportunity to receive more tailored information and to ask questions (Dolan et al., 2004; Grime et al., 2007). Moreover, the amount of information on the Internet can be overwhelming, and it can be difficult to assess the reliability of websites (Lagan et al., 2006; Lagan et al., 2010; Lima-Pereira et al., 2012). However, written information (Internet or leaflets) can be supplementary, and is an opportunity to reconstruct conversations about preconception care as a large amount of the medical information provided by professional caregivers is forgotten immediately (Kessels, 2003).

Overall, preconception-related information needs were high. Women were especially interested in information about lifestyle (nutrition, sport and leisure), environmental exposures, working conditions and medical issues (physical and mental disorders, infectious diseases, and vaccination). Information needs regarding substance use (smoking, alcohol, drugs), financial aspects, fertility and sexuality were low. A qualitative study of van der Zee et al. (2013) found that women's foremost preconception-related concern was about their fertility. In contrast with the findings of the present study, they found that women were particularly interested in information about the menstrual cycle and fertility. One participant even stated that information on fertility is the most important component of preconception care. A qualitative pilot study of Christiaen & Dhaenens (2014) found similar results. Fifteen women who were planning a pregnancy in the near future or trying to conceive were interviewed to explore preconception-related needs. Their findings suggest that women were more interested in information about their fertility and how to increase their likelihood of pregnancy than information about becoming pregnant in a healthy manner. It is possible that especially women with a strong desire to become pregnant or women struggling to conceive were more interested in being interviewed as it may be therapeutic for participants to share their story. The present study only assessed plans to become

pregnant, and not how long couples had been trying to conceive or the strength of their desire to conceive. Another interesting finding is that 81% of women stated that they drink alcohol (average of three drinks a week), but only 21% wanted to be informed preconceptionally about alcohol consumption before and during pregnancy. A Swedish study on the prevalence of alcohol use before and during pregnancy found that the majority of women (84%) drink alcohol until they discover they are pregnant (Skagerstrom et al., 2013). Stephenson et al. (2014) determined the extent to which women prepare for pregnancy. Results showed that 61% of the women reported consuming alcohol in the three months before pregnancy. So, although the majority of women might be aware of the risks of alcohol consumption during pregnancy, they may consume it in the critical first trimester of pregnancy. Therefore, the provision of information about alcohol is an important part of preconception information, regardless of women's perceived needs.

Information needs were higher among women with certain medical conditions, including women with (history of) mental illness, (history) of eye or otolaryngological problems and overweight. Being overweight was also significantly associated with higher lifestyle-related support needs. In particular, women who want to become pregnant are more receptive to health promotion as they know that a healthy lifestyle increases the likelihood of good reproductive outcomes (World Health Organization, 2013). The fact that overweight women want information and support to achieve a healthy lifestyle before and during pregnancy could be part of the battle against the worldwide obesity epidemic, and may have a positive effect on public health (World Health Organization, 2014).

Limitations

This study has some methodological limitations. First, based on education and nationality, people with a lower socio-economic profile were under-represented in the pilot test. As a result, it is possible that specific preconception needs of this group were missed. Second, women were recruited on a voluntary basis via a Women's Clinic and online through social media and forums, which may increase the risk of selection bias. Third, based on the sample characteristics (including education, occupation, marital status, nationality and health status), this sample over-represents women with a higher socio-economic profile. People with a higher socio-economic status are more likely to have a healthy lifestyle and a positive attitude towards healthy behaviors (Lynch et al., 1997; Wardle and Steptoe, 2003). It is possible that the actual needs and attitude of reproductive-aged women towards preconception care are different or less positive than the study findings suggest. Fourth, this study did not control for the possible influence of the different recruitment methods (online versus hospital). Fifth, inferential statistical analysis was not always possible due to small cell

frequencies, which made it impossible to identify all associations between the independent variables and preconception-related needs.

Further research

It would be interesting to assess men's needs regarding preconception care, as several authors have advocated a care approach that also addresses men (Johnson et al., 2006; Frey et al., 2008; Moos, 2010). Frey et al. (2008) identified several advantages of targeting men, including a reduced number of unplanned pregnancies through greater involvement regarding contraceptive decision making, improved pregnancy outcomes by reducing the likelihood of sperm DNA damage, and increased male support towards a healthy family lifestyle. Further research on the preconception-related needs of men and women with a lower socio-economic status would also be useful. Socially vulnerable groups often have poorer health status and exhibit more risk behaviors that could have an adverse effect on pregnancy outcome (de Graaf et al., 2013; Larranaga et al., 2013). Therefore, this group could benefit greatly from preconception care (Johnson et al., 2006). As socially vulnerable groups are more difficult to reach, it is important to adopt a need-based approach and tailor preconception care to their profile and needs (Department of Health, 2002). Therefore, it is important to collect data in settings that include socially vulnerable groups.

Implications for Midwifery

This needs assessment can be a first step in developing an intervention tailored to the needs of reproductive-aged women. International literature has revealed that participants like tailored interventions; and read, remember and discuss the content of it more often than standardized interventions (Ryan and Lauver, 2002). Moreover, evidence suggests that tailored interventions are equally or more effective in comparison to standardized interventions (Ryan and Lauver, 2002). A tailored intervention can be effective to promote preconception care among reproductive-aged women. Although gynecologists were the preferred source of preconception care in this study, primary caregivers (midwives and general practitioners) are also – or even more – appropriate professionals to provide this care as preconception care is part of primary and preventive medicine (Johnson et al., 2006). In contrast to general practitioners, most midwives do not consider preconception care as part of their professional domain (van Heesch et al., 2006). However, these results indicate that the midwife can play a more prominent role in providing preconception care. Seventy-three per cent of the women indicated that they want to receive preconception care from midwives, which is 10% higher than the result for general practitioners. Moreover, general practitioners perceive several barriers to providing preconception care which midwives may not experience, including time constraints and competing preventive priorities (Mazza, Chapman, Michie, 2013). In order to play a more prominent role in providing preconception

care, midwives would need training to deliver this care more confidently, and to improve their knowledge, skills and awareness (Heyes et al., 2004; van Heesch et al., 2006). The organization of health care in Belgium also influences the role of the midwife in preconception care. The financing of health care in Belgium is based on a fee-for-service payment model with the so-called 'nomenclature' which lists the reimbursed medical services and gives them a relative value (van den Oever and Volckaert, 2008; Gerkens and Merkur, 2010). Providing preconception care is not listed in the nomenclature. If a woman visits a gynecologist or general practitioner for preconception care, the health care professional can categorize it as a general consultation and the cost of this consultation will be reimbursed. If a woman visits a midwife for preconception care, this care will not be reimbursed as midwifery care is only refunded in the context of pregnancy, labor and birth, and postpartum care. By reimbursing the provision of preconception care by a midwife, the Belgian government could acknowledge and support the role of the midwife in preconception care. Moreover, it would be a signal of the Belgian government that they recognize the importance of preconception care.

CONFLICT OF INTEREST STATEMENT

Non declared.

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REFERENCES

Atrash, H., Jack, B.W., Johnson, K., 2008. Preconception care: a 2008 update. Curr. Opin. Obstet.Gynecol. 20, 581-589.

Atrash, H.K., Johnson, K., Adams, M., Cordero, J.F., Howse, J., 2006. Preconception care for improving perinatal outcomes: the time to act. Matern. Child Health J. 10, S3-11.

Bartholomew, L.K., Parcel, G.S., Kok, G., Gottlieb, N.H., Fernàndez, M.E., 2011. Planning Health Promotion Programs: An Intervention Mapping Approach., 3rd edn. Jossey Bass, San Fransisco.

Bradshaw, J., 1972. A taxonomy of social need. In: Mclachlan, G. (Ed.), Problems and Progress in Medical Care. Oxford University Press, Oxford.

Bursac, Z., Gauss, C.H., Williams, D.K., Hosmer, D.W., 2008. Purposeful selection of variables in logistic regression. Source Code Biol. Med. 3, 17.

Buziarsist, J., Demarest, S., Gisle, L., Tafforeau, J., Van der Heyden, J., Van Oysen, H., 2002. Gezondheidsenquête door middel van interview [Health Interview Survey]. Wetenschappelijk Instituut Volksgezondheid, Brussel, België 2001.

Cammu, H., Martens, E., De Coen, K., Defoort, P., 2005. Perinatale activiteiten en in Vlaanderen [Perinatal Activities in Flanders]. Studiecentrum voor Perinatale Epidemiologie, Brussels, 2004.

Cammu, H., Martens, E., De Coen, K., Defoort, P., 2014. Perinatale Activiteiten in Vlaanderen [Perinatal Activities in Flanders]. Studiecentrum voor Perinatale Epidemiologie, Brussels, 2013.

Christiaen, S., Dhaenens, C., 2014. De preconceptionele noden van vrouwen met een kinderwens [The Preconceptional Needs of Women with a Desire to have Children]. Faculty of Medicine and Health Sciences. Ghent University, Ghent.

Christianson, A., Howson, C.P., Modell, B., 2006. Global Report on Birth Defects: The Hidden Toll of Dying and Disabled Children. March of Dimes Birth Defects Foundation, New York.

Corchia, C., Mastroiacovo, P., 2013. Health promotion for children, mothers and families: here's why we should "think about it before conception". Ital. J. Pediatrics 39, 68.

de Graaf, J.P., Steegers, E.A., Bonsel, G.J., 2013. Inequalities in perinatal and maternal health. Curr. Opin. Obstet. Gynecol. 25, 98-108.

de Jong-Potjer, L.C., de Bock, G.H., Zaadstra, B.M., de Jong, O.R., Verloove-Vanhorick, S.P., Springer, M.P., 2003. Women's interest in GP-initiated pre-conception counselling in The Netherlands. Fam. Pract. 20, 142-146.

Department of Health, 2002. Addressing Inequalities – Reaching the Hard-to-reach Groups. National Service Framework: A Practical Aid to Implementation in Primary Care. Department of Health, London.

Dolan, G., Iredale, R., Williams, R., Ameen, J. ,2004. Consumer use of the internet for health information: a survey of primary care patients. Int. J. Consum. Stud. 28, 147-153.

Emons, J.K., Luiten, M.I., 2001. Midwifery in Europe. The European Midwives Liaison Committee, The Netherlands.

Frey, K.A., Files, J.A., 2006. Preconception healthcare: what women know and believe. Matern. Child Health J. 10, S73-S77.

Frey, K.A., Navarro, S.M., Kotelchuck, M., Lu, M.C., 2008. The clinical content of preconception care: preconception care for men. Am. J. Obstet. Gynecol. 199, S389-S395.

Gerkens, S., Merkur, S., 2010. Belgium: Health system review. Health Syst. Transit. 12, 1-266, xxv.

Grime, J., Blenkinsopp, A., Raynor, D.K., Pollock, K., Knapp, P., 2007. The role and value of written information for patients about individual medicines: a systematic review. Health Expect 10, 286-298.

Grimes, H.A., Forster, D.A., Newton, M.S., 2014. Sources of information used by women during pregnancy to meet their information needs. Midwifery 30, e26-e33.

Hacker, N.F., Gambone, J.C., Hobel, C.J., 2010. Hacker & Moore's Essentials of Obstetrics and Gynecology, 5 edn. W.B. Saunders, Philadelphia.

Haque, K.N., Hayes, A.M., Ahmed, Z., Wilde, R., Fong, C.Y., 2008. Caesarean or vaginal delivery for preterm very-low-birth weight (< or =1,250 g) infant: experience from a district general hospital in UK. Arch. Gynecol. Obstet. 277, 207-212.

Heyes, T., Long, S., Mathers, N., 2004. Preconception care: practice and beliefs of primary care workers. Fam. Pract. 21, 22-27.

Jaddoe, V. W., de Jonge, L. L., Hofman, A., Franco, O. H., Steegers, E. A., Gaillard, R. (2014). First trimester fetal growth restriction and cardiovascular risk factors in school age children: population based cohort study. Br. Med. J. 348, g14.

Johnsen, A.T., Petersen, M.A., Pedersen, L., Groenvold, M., 2011. Development and initial validation of the Three-Levels-of-Needs Questionnaire for self-assessment of palliative needs in patients with cancer. J. Pain Symptom Manag. 41, 1025-1039.

Johnson, K., Posner, S.F., Biermann, J., et al., 2006. Recommendations to improve preconception health and health care--United States. A report of the CDC/ATSDR Preconception Care Work Group and the Select Panel on Preconception Care. MMWR. Recommendations and reports: Morbidity and mortality weekly report. Recommendations and reports/Centers for Disease Control 55, 1-23.

Kealy, M.A., Small, R.E., Liamputtong, P., 2010. Recovery after caesarean birth: a qualitative study of women's accounts in Victoria, Australia. BMC Pregnancy Childbirth 10, 47.

Kessels, R.P., 2003.Patients' memory for medical information. J.R.Soc.Med. 96, 219-222.

Lagan, B.M., Sinclair, M., Kernohan, W.G., 2010. Internet use inpregnancy informs women's decision making: a web-based survey. Birth 37, 106-115.

Lagan, B.M., Sinclair, M., Kernohan, W.G., 2006. Pregnant women's use of the internet: a review of published and unpublished evidence. Evidence Based Midwifery 4, 17-23.

Larranaga, I., Santa-Marina, L., Begiristain, H., et al., 2013. Socio-economic inequalities in health, habits and self-care during pregnancy in Spain. Matern. Child Health J. 17, 1315-1324.

Larsson, M., 2009. A descriptive study of the use of the Internet by women seeking pregnancy-related information. Midwifery 25,14-20.

Li, Z., Zeki, R., Hilder, L., Sullivan, E.A., 2013. Australia's mothers and babies 2011, perinatal statistics series no. 28. AIHW National Perinatal Epidemiology and Statistics Unit, Canberra.

Liu, S., Liston, R.M., Joseph, K.S., Heaman, M., Sauve, R., Kramer, M.S., 2007. Maternal mortality and severe morbidity associated with low-risk planned cesarean delivery versus planned vaginal delivery at term. Can. Med. Assoc. J. 176, 455-460.

Lima-Pereira, P., Bermúdez-Tamayo, C., Jasienska, G., 2012. Use of the internet as a source of health information amongst participants of antenatal classes. J.Clin. Nurs. 21, 322-330.

Lynch, J.W., Kaplan, G.A., Salonen, J.T., 1997. Why do poor people behave poorly? Variation in adult health behaviours and psychosocial characteristics by stages of the socioeconomic lifecourse. Soc. Sci. Med. 44, 809-819.

March of Dimes Foundation, 2009. White Paper on Preterm Birth: the Global and Regional Toll. March of Dimes Foundation, New York.

Mazza, D., Chapman, A., Michie, S., 2013. Barriers to the implementation of preconception care guidelines as perceived by general practitioners: a qualitative study. BMC Health Serv. Res. 13, 36.

Moos, M.K., 2010. From concept to practice: reflections on the preconception health agenda. J. Women's Health 19, 561-567.

Moreira, R.S., Magalhaes, L.C., Alves, C.R., 2014. Effect of preterm birth on motor development, behavior, and school performance of school-age children: a systematic review. J. Pediatria 90, 119-134.

Polit, D.F., Beck, C.T., 2010. Essentials of Nursing Research: Appraising Evidence for Nursing Practice. Wolters Kluwer Health/Lippincott Williams & Wilkins.

Posner, S.F., Broussard, D.L., Sappenfield, W.M., Streeter, N., Zapata, L.B., Peck, M.G., 2008. Where are the data to drive policy changes for preconception health and health care? Women's Health Issues 18, S81-S86.

Punch, K.F., Horner, B., 1991. Stages in the development of a needs assessment questionnaire. J. Nurs. Staff Dev. 7, 176-180.

Queensland Centre for Mothers and Babies, 2010. Choosing your Model of Care. A Decision Aid for Pregnant Women Choosing their Maternity Care Provider. University of Queensland, Brisbane.

Ryan, P., Lauver, D.R., 2002. The efficacy of tailored interventions. J. Nurs. Scholarsh. 34, 331-337.

Shannon, G.D., Alberg, C., Nacul, L., Pashayan, N., 2014. Preconception healthcare and congenital disorders: systematic review of the effectiveness of preconception care programs in the prevention of congenital disorders. Matern. Child Health J. 18, 1354-1379.

Silver, R.M., 2012. Implications of the first cesarean: perinatal and future reproductive health and subsequent cesareans, placentation issues, uterine rupture risk, morbidity, and mortality. Semin. Perinatol. 36, 315-323.

Skagerstrom, J., Alehagen, S., Haggstrom-Nordin, E., Arestedt, K., Nilsen, P., 2013. Prevalence of alcohol use before and during pregnancy and predictors of drinking during pregnancy: a cross sectional study in Sweden. BMC Pub. Health 13, 780.

Stephenson, J., Patel, D., Barrett, G., Howden, B., Copas, A., Ojukwu, O., Pandya, P., Shawe, J., 2014. How do women prepare for pregnancy? Preconception experiences of women attending antenatal services and views of health professionals. PloS One 9, e103085.

van den Oever, R., Volckaert, C., 2008. Financing health care in Belgium. The nomenclature: from fee-for-service to budget-financing. Acta chirurgica Belgica 108, 157-166.

van der Pal-de Bruin, K.M., le Cessie, S., Elsinga, J., et al., 2008. Pre-conception counselling in primary care: prevalence of risk factors among couples contemplating pregnancy. Paediatric Perinatal Epidemiol. 22, 280-287.

van der Zee, B., de Beaufort, I.D., Steegers, E.A., Denktas, S., 2013. Perceptions of preconception counselling among women planning a pregnancy: a qualitative study. Fam. Pract. 30, 341-346.

van Heesch, P.N., de Weerd, S., Kotey, S., Steegers, E.A., 2006. Dutch community midwives' views on preconception care. Midwifery 22, 120-124.

Vermaes, I.P., Janssens, J.M., Bosman, A.M., Gerris, J.R., 2005. Parents' psychological adjustment in families of children with spina bifida: a meta-analysis. BMC Pediatrics 5, 32.

Wardle, J., Steptoe, A., 2003. Socioeconomic differences in attitudes and beliefs about healthy lifestyles. J. Epidemiol. Community Health 57, 440-443.

Wolff, T., Witkop, C.T., Miller, T., Syed, S.B., 2009. U.S. Preventive Services Task Force Evidence Syntheses, formerly Systematic Evidence Reviews, Folic Acid Supplementation for the Prevention of Neural Tube Defects: An Update of the Evidence for the U.S. Preventive Services Task Force. Agency for Healthcare Research and Quality (US), Rockville (MD).

World Health Organization, 2013. Meeting to Develop a Global Consensus on Preconception Care to Reduce Maternal and Childhood Mortality and Morbidity: World Health Organization Headquarters, Geneva, 6-7 February 2012.

World Health Organization, 2014. Obesity and Overweight. Fact Sheet No. 311.

Supplementary data: "NEEDS ASSESSMENT" QUESTIONNAIRE

Part 1: Demographics

1. What is your nationality? [Belgian / Other, namely: …]
2. What is your year of birth? [19..]
3. What is your highest degree of education completed? [None / primary education / lower secondary education / higher secondary education / further secondary education / higher education: bachelor degree / higher education: master degree]
4. What is your professional situation? [I am in full-time or part-time paid employment / I am a student / I am a jobseeker / I live on a living wage / I am a housewife / other, namely…]
5. What is your living status? [Living with my partner and/or children / Living alone / Living with my parents / Living with others, namely… / Supervised independent living / Other, namely…]
6. What is your marital status? [Married or living with my partner / In a relationship, but not living with my partner / Not in a relationship / Divorced / Widowed / Other, namely…]
7. Are you planning a pregnancy? [I am considering to become pregnant within 3 to 5 year / I am considering to become pregnant within 2 years / I am currently trying to get pregnant / I do not have any pregnancy plans at this moment]

Part 2: Medical history

1. How is your health in general? [Very good / Good / Average / Poor / Very poor]
2. Do you have a medical condition or disease that involves ….
    a. the blood, heart, or blood vessels, including high blood pressure, anaemia, leukaemia, congenital heart disease, coagulation disease, vascular or aorta disease, abnormal heart rhythms or another disorder? [No / Yes]
    b. the bones, muscles or nerve system, including arteritis, rheumatic disease, epilepsy, multiple sclerosis, migraine, Parkinson's disease, lumbago, inflammatory nerve disorder or another disorder? [No / Yes]
    c. the skin, including psoriasis, eczema, cysts or another disorder? [No / Yes]
    d. the endocrinal (hormonal) system, including diabetes, overweight, thyroid disorder or another disorder [No / Yes]
    e. a mental disorder, including eating disorder, depression, suicide, neurosis, psychosis, bipolar disorder or another mental disorder? [No / Yes]
    f. the respiratory system, including asthma, emphysema, or another disorder? [No / Yes]
    g. the gastrointestinal system, including an oesophageal disease, gastric disease, small intestine disease, large intestine disease, rectum disease, hepatic disease, pancreatic or gallbladder disease or another disorder? [No / Yes]
    h. the eye, ear and throat, including reduced visibility, reduced hearing, deafness or another disorder? [No / Yes]
    i. an infection or parasitic disease, including hiv, aids, malaria, STD or another infection? [No / Yes]
    j. the urinary system, including renal or urinary tract disorder, incontinence or another disorder? [No / Yes]
    k. allergies, including contact allergies, nutritional allergies, hay fever or other allergies? [No / Yes]
    l. sexual or breast medical conditions? [No / Yes]
    m. the reproductive system or obstetric problems, including fertility problems, disorders of the uterus, miscarriage, ectopic pregnancy, low birth weight, gestational diabetes, eclampsia or another disorder? [No / Yes]
    n. a congenital or hereditary disorder, including spina bifida, cystic fibrosis or another disorder? [No / Yes]
    o. Do you have another disorders or diseases not mentioned so far? [No / Yes]

3. Do you smoke? [I have never smoked / I used to smoke, but not anymore / I smoke less than daily / I am a daily smoker]
4. Do you consume alcohol? [I have never consumed alcohol / I used to consume alcohol, but not anymore / I consume alcohol with an average of …. drinks a week]
5. Do you use drugs? [No / I have used drugs, but not anymore / Yes]
6. What is your current height […. cm] and weight [… kg]
7. Have you been pregnant before? [No / Yes]
    a. If yes, how many pregnancies ended in a living birth? …
    b. If yes, how many pregnancies ended in a miscarriage? …
    c. If yes, how many pregnancies ended in a stillbirth? …
    d. If yes, how many pregnancies ended in an abortion provocates? …

Part 3: Organisation of preconception care*

*Preconception care is the provision of health information and/or guidance by professional caregivers or other sources in the period the conception occurs, with the aim to improve maternal and child health outcomes. It encompasses information and/or guidance regarding for example nutrition, sports and physical activity, fertility, smoking, infection diseases.

1. Have you received preconception care in the past? [No / Yes]
   If yes, from who or where did you received this care? Multiple answers allowed [GP / midwife / gynaecologist / medical specialist / family / friends / websites / leaflets / books / media / school / other, namely…]
2. Do you want to receive (more) preconception care in the future? [No / Yes]
   If yes, which is your preferred source of preconception care? Multiple answers allowed [directly from a professional caregiver / leaflets / websites / books / other, namely…]
3. From which professional caregiver(s) do you prefer to receive preconception care? Multiple answers allowed [GP / midwife / gynaecologist / other, namely …]
4. From which professional caregiver would you preferably receive preconception care? Only one answer allowed [GP / midwife / gynaecologist / other, namely …]
5. I prefer to receive preconception care through a preconception consult (personal contact with professional caregiver) above information through leaflets, books, websites… [completely agree / agree / neutral / disagree / completely disagree]
6. I would like to have multiple consultations to explore certain topics extensively and monitor my health [completely agree / agree / neutral / disagree / completely disagree]

Part 4: Preconception-related information

1. Have you received information regarding a healthy lifestyle in the past (e.g., healthy nutrition, physical activity, tobacco use, alcohol use, drug use…)? [No / Yes]
   If yes, from who or where did you received this information? Multiple answers allowed [GP / midwife / gynaecologist / medical specialist / family / friends / websites / leaflets / books / media / school / other, namely…]
2. Have you received information regarding fertility and pregnancy with medical conditions (e.g., the occurrence of a genetic or hereditary disease in the family, the use of medication, the influence of a medical condition or infectious disease on pregnancy)? [No / Yes]
   If yes, from who or where did you received this information? Multiple answers allowed [GP / midwife / gynaecologist / medical specialist / family / friends / websites / leaflets / books / media / school / other, namely…]

3. Have you received information regarding sexuality and fertility (e.g., sexual education, birth control, menstrual cycle, reproduction, STD…)? [No / Yes]
   If yes, from who or where did you received this information? Multiple answers allowed [GP / midwife / gynaecologist / medical specialist / family / friends / websites / leaflets / books / media / school / other, namely…]

Response options for all following information needs items: (1) 'Yes, I am not informed yet', (2) 'Yes, I am already partially informed, but want more information, (3) 'No, I do not need this information, and (4) 'No, I am already fully informed'.

4. Do you need information regarding the course of a pregnancy, delivery, and postpartum period?
5. Do you need information regarding the support or care you can receive before and during the pregnancy, delivery, postpartum period (e.g., guidance of a midwife, day care, maternity help…)?
6. Do you need information regarding your rights and obligations before and during pregnancy and postpartum period (e.g., child benefits, maternity leave, maternity protection, birth registration…)?
7. Do you need information regarding the influence of working conditions on fertility and pregnancy? (e.g., work-related stress, a physically demanding job, contact with potential harmful substances, professional contact with children, working in shifts, night work…)
8. Do you need information regarding the influence of environmental exposures on fertility and pregnancy (e.g., mercury, lead, asbestos, cleaning products, paint, hair dye…)
9. Do you need information regarding a healthy weight (e.g., what is a healthy weight, how to obtain and retain a healthy weight…)?
10. Do you need information regarding physical activity (e.g., what is physical activity and how can I be physical active…)?
11. Do you need information regarding the potential consequences of certain sports and leisure activities (e.g. running or a sauna visit) on the fertility and pregnancy?
12. Do you need information regarding nutrition before and during the pregnancy (what is safe to eat and what not, what is a healthy nutrition…)?
13. Do you need information regarding nutritional supplements before and during pregnancy (e.g. folic acid, multivitamins, iron…)?
14. Do you need information regarding the consequences of smoking and second-hand smoke on fertility and pregnancy?
15. Do you need information regarding the consequences of alcohol use on fertility and pregnancy?
16. Do you need information regarding the consequences of using drugs on fertility and pregnancy?
17. Do you need information regarding the influence of the family medical or genetic history on fertility and pregnancy (e.g., information regarding the changes of having a child with a certain disorder or disease if this disorder or disease runs in the family, such as diabetes mellitus, hereditary cancers, syndrome of Down)?
18. Do you need information regarding the influence of a medical condition on fertility and pregnancy (e.g., the influence of diabetes mellitus, high blood pressure, asthma, epilepsy, hereditary cancer… on the unborn child)?
19. Do you need information regarding the influence of a pregnancy on a medical condition (e.g., the influence of a pregnancy on back problems, diabetes mellitus, heart diseases, respiratory diseases, relapse of cancer…)?
20. Do you need information regarding the influence of a mental disorder on fertility and pregnancy (e.g., the influence of a depression, eating disorder, bipolar disorder, schizophrenia… on the unborn child)?
21. Do you need information regarding the influence of a pregnancy on a mental disorder (e.g., the influence of a pregnancy on a depression, eating disorder…)?
22. Do you need information regarding the consequences of medication on fertility and pregnancy (both homeopathy, medication on prescription, and over-the-counter medication such as painkillers)?

23. Do you want information regarding steps to prevent certain infectious diseases (e.g., toxoplasmosis, cytomegalic, listeriosis…) during pregnancy (e.g. hygiene, avoid eating raw fish and meat…)?
24. Do you need information regarding vaccinations against certain infectious diseases (e.g., rubella, influenza, hepatitis A and/or B…)?
25. Do you need information regarding sexuality and fertility (e.g., functioning of reproductive organs, problems during sexual intercourse…)?
26. Do you need information regarding increasing your pregnancy changes (e.g., menstrual cycle, tools to test when you are the most fertile or have an ovulation, pregnancy tests…)?
27. Do you need information regarding sexual transmitted diseases (e.g., hiv and aids, syphilis, gonorrhea, chlamydia, herpes infection…)?
28. Do you need information regarding becoming pregnant after a previous difficult pregnancy or delivery (e.g., miscarriage, ectopic pregnancy, preterm birth, gestational diabetes, stillbirth…)?
29. Do you need information regarding the influence of a pregnancy and child on your personal and social life (e.g., combination of motherhood and working, the impact of a child on your spare time…)?
30. Do you need information regarding the influence of a pregnancy and child on the relationship with your partner (e.g., influence on intimacy and sexuality…)?
31. Do you need information regarding financial matters and support?
32. Do you need information regarding relational problems or behaviours such as being physical hurt (e.g., beating, kicking…), emotional hurt (threating, humiliating, ignoring…) or sexual hurt (e.g. sexual acts without permission…) and the consequences on a pregnancy?
33. Do you need information regarding other issues not mentioned so far? [No / Yes, namely…]

Part 5: Preconception-related support needs

Response options for all following support needs items: (1) 'Yes, I am not supported yet', (2) 'Yes, I am already partially supported, but want more support, (3) 'No, I do not need this support, and (4) 'No, I am already fully supported'.

1. Do you need support to obtain a healthy weight?
2. Do you need support to become physical active?
3. Do you need support to adopt healthy and appropriate nutrition?
4. Do you need support to stop or reduce smoking?
5. Do you need support to stop or reduce alcohol use?
6. Do you need support to stop or reduce drug use?
7. Do you need support because of a medical condition (e.g., diabetes mellitus, high blood pressure, asthma, epilepsy…)
8. Do you need support because of a mental disorder (e.g. depression, eating disorder, phobia…)
9. Do you need support because of a family medical or genetic history (e.g., when a certain disease runs in the family such as hereditary diseases, syndrome of Down…)?
10. Do you need support because of an obstetrical problem (e.g., miscarriage, stillbirth…)
11. Do you need support because of relational problems or behaviours such as being physical hurt (e.g., beating, kicking…), emotional hurt (threating, humiliating, ignoring…) or sexual hurt (e.g. sexual acts without permission…) and the consequences on a pregnancy?
12. Do you need support because of financial matters?
13. Do you need support regarding other issues not mentioned so far? [No / Yes, namely…]

CHAPTER 3

PSYCHOMETRIC PROPERTIES OF THE DUTCH VERSION OF THE LONDON MEASURE OF UNPLANNED PREGNANCY IN WOMEN WITH PREGNANCIES ENDING IN BIRTH

Based on the article of Goossens, J., Verhaeghe, S., Van Hecke, A., Barrett, G., Delbaere, I., Beeckman, D. (2018). Psychometric properties of the Dutch version of the London Measure of Unplanned Pregnancy in women with pregnancies ending in birth. Accepted for publication in PLOS ONE. Category: MULTIDISCIPLINARY SCIENCES: 15/64 (Q1) – IF: 2.806.

ABSTRACT

Objective: To evaluate the psychometric properties of the Dutch version of the London Measure of Unplanned Pregnancy in women with pregnancies ending in birth.

Methods: A two-phase psychometric evaluation design was set-up. Phase I comprised the translation from English into Dutch and pretesting with 6 women using cognitive interviews. In phase II, the reliability and validity of the Dutch version of the LMUP was assessed in 517 women giving birth recently. Reliability (internal consistency) was assessed using Cronbach's alpha, inter-item correlations, and corrected item-total correlations. Construct validity was assessed using principal components analysis and hypothesis testing. Exploratory Mokken scale analysis was carried out.

Results: 517 women aged 15-45 completed the Dutch version of the LMUP. Reliability testing showed acceptable internal consistency (alpha=0.74, positive inter-item correlations between all items, all corrected item-total correlations >0.20). Validity testing confirmed the unidimensional structure of the scale and all hypotheses were confirmed. The overall Loevinger's H coefficient was 0.57, representing a 'strong' scale.

Conclusion: The Dutch version of the LMUP is a reliable and valid measure that can be used in the Dutch-speaking population in Belgium to assess pregnancy planning. Future research is necessary to assess the stability of the Dutch version of the LMUP, and to evaluate its psychometric properties in women with abortions.

INTRODUCTION

Unplanned pregnancies have been associated with more unhealthy perinatal behavior and an increased risk of several adverse antenatal and birth outcomes, including spontaneous abortion, congenital anomalies, preterm birth, and low birth weight (Mohllajee et al., 2007; Gipson et al., 2008; Shah et al., 2011; Dibaba et al., 2013; Goossens et al., 2016; Hall et al., 2017a). Prevention of unplanned pregnancy has become a global health priority (U.S. Department of Health and Human Services, 1990; World Health Organization, 2010; U.S. Department of Health and Human Services, 2010; United Nations, 2015).

Estimating the prevalence of unplanned pregnancy is important for the design and evaluation of effective preconception care initiatives and strategies for unintended pregnancy prevention, for example school- or community-based sex education programs, contraceptive education programs, and the provision of no-cost (emergency) contraception (Trussell et al., 1992; DiCenso et al., 2002; Secura et al., 2010; Frayne et al., 2016). In the past, there have been numerous attempts to measure pregnancy planning, primarily by the means of survey questions. Many of these studies fail to measure pregnancy planning adequately due to methodological challenges, including lack of clear definitions, the utilization of measures without rigorous psychometric

evaluation, and difficulties with conceptualizing pregnancy intention or planning (Petersen and Moos, 1997; Campbell and Mosher, 2000; Klerman, 2000). Most conventional measures of pregnancy intention or planning assume that becoming pregnant is a conscious choice and/or women have well defined family building plans (Petersen and Moos, 1997; Fischer et al., 1999; Barrett and Wellings, 2002; Santelli et al., 2003). For example, the 2013 – 2015 National Health and Family Growth (NSFG) – the primary data source on pregnancy intention in the United States – asks a series of questions regarding the timing and desire for children including; 'Right before you became pregnant…, did you yourself want to have a(nother) baby at any time in the future?'(CDC/National Center for Health Statistics, 2016). The pregnancy intendedness is categorized into three categories: 'intended', 'mistimed', and 'unwanted'. A pregnancy is categorized as 'intended' if a woman indicated that her pregnancy occurred at the time she wanted to become pregnant, or later, or if she didn't care about the timing of the pregnancy. A pregnancy is classified as 'mistimed' if the pregnancy occurred sooner than the woman wanted. If a woman states she wanted no more children for the rest of her life, it was categorized as 'unwanted'. 'Unintended' pregnancies refer to 'mistimed' and 'unwanted' pregnancies (Chandra et al., 2005). The problem with measures that categorize pregnancy intention and planning in a dichotomous manner, namely intended *versus* unintended and planned *versus* unplanned, is that it leads to oversimplification of a complex construct (Klerman, 2000; Santelli et al., 2003). Several studies have shown that some women experience conflicting attitudes and feelings towards preventing a pregnancy or fail to form explicit intentions about their fertility, which can result in inadequate contraceptive use (Trussell et al., 1999; Barrett and Wellings, 2002; Schwarz et al., 2007; Higgins et al., 2012; Borrero et al., 2015). This complexity is rarely captured in conventional survey questions, and therefore, continuous or multi-item measures might be more appropriate to measure the construct of pregnancy intention or planning (Bachrach and Newcomer, 1999; Klerman, 2000; Stanford et al., 2000; Santelli et al., 2003)

The London Measure of Unplanned Pregnancies (LMUP) is an instrument that takes the complexity of pregnancy planning into account (Barrett et al., 2004). The LMUP was developed in the United Kingdom (UK) based on qualitative research, and has been assessed as valid and reliable (Cronbach's α = 0.92, test–retest = 0.97) (Barrett et al., 2004). It does not assume that women have fully developed childbearing plans nor that their behavior is consistent with their intentions, which allows them to express ambivalence about becoming pregnant. Because previously conducted qualitative research suggests that women do not differentiate between the terms 'planning' and 'intending' a pregnancy, these terms are used as synonyms (Barrett and Wellings, 2002; Rocca et al., 2010). The LMUP is a short, inoffensive, easy to understand, self-administered measure, and therefore, suitable for use in large scale studies (original version in English is available at www.lmup.org.uk). The LMUP has been translated into other languages including Spanish, Portuguese, Urdu,

Arabic, and Persian; and its psychometric properties have been evaluated in different populations and settings (Rocca et al., 2010; Morof et al., 2012; Hall et al., 2013; Roshanaei et al., 2015; Borges et al., 2016; Almaghaslah et al., 2017; Habib et al., 2017). The LMUP may also be a useful tool for assessing the prevalence of unplanned pregnancies in Dutch-speaking regions as no national data registration or questionnaires are available. However, psychometric properties of the Dutch translation of the LMUP are required. Therefore, the aim of this analysis, as part of the wider study on pregnancy planning in Flanders (Goossens et al., 2016), was to translate the LMUP into Dutch and to evaluate its psychometric properties (validity and reliability) among women in Flanders, Belgium, who had a pregnancy ending in birth.

Study context

Belgium is a federal, high-income country in North-Europe with a population of 11 million people. The two largest regions in the country are the Dutch-speaking region of Flanders in the north and the French-speaking region in the south (Wallonia). The Brussels-Capital region is officially bilingual (French and Dutch) (Federal Public Service for Foreign Affairs, 2015). Approximately 25% of the Belgian population are women of reproductive age (15 – 45 years) (Belgium, 2016). Over the past few decades, the fertility of women in Flanders has followed a trend toward postponement and decline of childbearing. In 1991, the mean age at first motherhood was 26.3 years, and steadily increased over the years to a mean age of 28.8 years in 2015 (Devlieger et al., 2016). In 2008, the total fertility rate (TFR) in Flanders was estimated at 1.66 children per woman; 1.77 in 2012; and further dropped to 1.66 in 2015 (Van Bavel and Nomes, 2016). Women in Flanders have easy access to birth control and emergency contraception. Data from the Belgian National Health Interview Survey of 2013 showed that 74% of the Flemish sexually active women aged 15–54 (or their partner) used contraception, including emergency contraction (Gisle and Demarest, 2014; Elaut et al., 2015). Official statistics showed that Belgium has one of the lowest abortion rates of the world, 9 abortions per 1,000 reproductive-age women (Sedgh et al., 2011). Belgian women who meet legal requirements (up to 12 weeks of gestation) have easy access to abortion services. In 2015, 222 (2.7%) of the women wanting an abortion were denied due to legal gestational age limits, of which 155 women (69.8%) considered an abortion elsewhere, 22.9% (n=51) carried the unwanted pregnancy to term, and information is missing on 16 women (7%)(unpublished data of LUNA, a Dutch-speaking organization of abortion centers in Belgium).

METHODS

The study included two phases. Phase I comprised the translation and adaption of the LMUP into the Dutch language. Phase II assessed the reliability and validity of the Dutch version of the LMUP.

Instrument

The LMUP measures retrospectively the extent to which the most recent pregnancy was planned/intended through six items related to stance (intention to conceive, and desire for a baby), context (timing of motherhood, and discussion with partner), and behavior (contraceptive use, and preconceptional preparations). Each item is scored zero, one or two, with a total sum score from zero to 12. Total scores can be treated as continuous, with a higher score indicating a higher degree of pregnancy planning (Barrett et al., 2004; Hall et al., 2017b). The total score can also be divided into three groups: 0–3 ('unplanned'), 4–9 ('ambivalent'), and 10–12 ('planned'), or dichotomized at scores 9/10 (unplanned/planned), depending on the requirements of the analysis (Barrett et al., 2004; Hall et al., 2017b).

Phase I: The Dutch Translation and adaption of the LMUP

The LMUP was translated, guided by the World Health Organization (WHO)'s process of translation and adaption of research instruments that consists of four steps: (1) forward translation, (2) expert panel, (3) backward translation, and (4) pre-testing and cognitive interviewing with a minimum of 10 respondents (World Health Organization, 2009). Due to time constraints, not all steps of this process were fully followed. First, two Dutch-speaking researchers (JG and SDB) who were fluent in English independently translated the LMUP into Dutch. A back-translation was not performed, but instead a third Dutch-speaking researcher (AVL) checked the adequacy of the translation, as well as the comprehensibility of the items. Next, the few discrepancies between the forward translation and the original wording, and suggestions for alternative expressions were discussed between the researchers. Finally, the translated questionnaire was pre-tested using cognitive interviewing techniques. Because of time constraints and the fact no new information was obtained in the last interviews, a sample of only 6 women who met the inclusion criteria were included in the pre-test. Women were recruited by snowball sampling, and were interviewed at home by a trained interviewer (JG). Respondents were instructed to read each item and response option aloud, and to explain what the question is asking, and whether they could rephrase the question in their own words. Respondents were also asked about wording they did not understand, as well as any words or expression that they found offensive or unacceptable. The women in the pre-test had mean age of 28.5 years with a range of 22 to 31 years. Most of them were low (n=1) or medium educated (n=3), and two women had college or university education. No immigrant women were interviewed.

Based on the debriefing of the pre-test respondents, minor changes were made. Firstly, one woman stated she did not understand the term "contraception" in the response options of item one, therefore, the term was replaced by "birth control". Secondly, three preconception health behaviors were added to the list of response options of item six: "I used multivitamins", "I stopped or reduced the consumption of caffeine containing

drinks", and "I achieved a healthier weight". These actions were added because they are more commonly taken by Flemish women preparing for pregnancy (multivitamin use), and because of international recommendations and studies on preconception health (reduction of caffeine and achieving a healthy weight) (Jack et al., 2008; Lassi et al., 2014; Temel et al., 2015). Adaptations to item 6 to ensure its local relevance is well established (Rocca et al., 2010; Hall et al., 2013) and supported by the developer (GB). Finally, three examples of commonly consumed caffeine containing drinks were added in parentheses (coffee, tea, cola soda,…) because two women reported they were unsure which drinks contain caffeine (S1 Instrument).

Phase 2: Reliability and validity of the LMUP

Participants and procedures

A detailed description of the methodology of this study is described elsewhere (Goossens et al., 2016). Briefly, 517 women (22% response rate) were enrolled in the study between March through September 2015 via six non-teaching public Hospitals in Flanders (Belgium). Women were eligible to participate if they were 1) admitted to the postnatal maternity ward, 2) between 15 and 45 years old, and 3) Dutch speaking. The head or study midwife of each postnatal ward was asked to approach all eligible women, and to inform them about the aim and procedures of the study on preparations before pregnancy. Women who agreed to participate in the study completed a one-time questionnaire during the first five days postpartum, and returned it in a sealed envelope to a midwife. Additionally, information on pregnancy, delivery, and birth outcomes was collected from medical records by two junior researchers (qualified midwives and master students in Midwifery). All the data were anonymised before further processing to ensure confidentiality. The study was approved by the Ethics Committee of Ghent University Hospital (B670201524084 & B670201524085) and all six local research ethics committees. All participants provided written informed consent. For women under the age of 18 years, written informed consent was also obtained from parents or legal guardians.

Data analysis

Psychometric properties of the Dutch version of the LMUP were assessed using the Classical Test Theory-based (CTT) approach to facilitate comparison with the original UK study (Barrett et al., 2004) and previous validations (Rocca et al., 2010; Morof et al., 2012; Hall et al., 2013; Roshanaei et al., 2015; Borges et al., 2016; Almaghaslah et al., 2017; Habib et al., 2017). Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 21 (IBM Corporation, Armonk, NY, USA) and Stata version 13 (Stata Corporation, College Station, TX, USA). P-values ≤ 0.05 were considered statistically significant.

Performance of the LMUP items. The amount of missing data for each item was assessed. Total scores were obtained by summing the score on each item; the three added actions of item six were assessed as "taking

another action". For participants missing one to three of the six item responses, scores for the missing items were imputed by using a mean score of the non-missing items allowing a total score to be calculated. If more than three items were missing, imputation of missing data was not carried out and no total score was calculated (Barrett et al., 2004). Item endorsement frequencies were calculated for each item to investigate if there were response options with a very high (> 80%) selection.

An analysis of the distribution of the total scores was performed to ensure the full range of scores were present and to evaluate the targeting of the measure. The readability of the Dutch version of the LMUP was evaluated by using the Flesch Reading Ease Score (FRES; 100-point scale; the higher the score, the easier to understand) and Flesch-Kincaid Grade Level (FKGL)(Kincaid et al., 1975).

Reliability of the LMUP. The internal consistency was evaluated by calculating the Cronbach's alpha coefficient, using 0.7 as cutoff for acceptable reliability (Polit and Beck, 2010). In addition, all corrected item-total correlations were assessed, with scores above 0.2 indicating an acceptable correlation between each item and the overall score (Streiner et al., 2014). Moreover, inter-item correlations were calculated to verify that all items were positively correlated.

Validity of the LMUP. Construct validity was assessed by using principal components analysis and hypothesis testing. The principal components analysis (PCA) was used to determine the number of underlying constructs. The LMUP was considered as valid if all items loaded onto one construct with an Eigenvalue greater than one (Polit and Beck, 2010). Construct validity hypotheses, using the known groups technique, were formulated a priori and were based on the findings from the original UK study (Barrett et al., 2004) and from literature (Joyce et al., 2000; Han et al., 2005; Pallitto et al., 2005; Mohllajee et al., 2007; Kuroki et al., 2008; Sarkar, 2008; Cheng et al., 2009; Xaverius et al., 2009; Dott et al., 2010; Miller et al., 2010; Postlethwaite et al., 2010; Maxson and Miranda, 2011; Takahashi et al., 2012; ; Azevêdo et al., 2013; Mallard and Houghton, 2013; Nelson and Lepore, 2013; Wellings et al., 2013; Yanikkerem et al., 2013; Stern et al., 2016). We hypothesized that the following women would have a lower level of pregnancy planning, and thus, lower LMUP median scores: 1) single women and women living without their partner (Barrett et al., 2004; Mohllajee et al., 2007; Cheng et al., 2009; Postlethwaite et al., 2010; Maxson and Miranda, 2011; Mallard and Houghton, 2013; Nelson and Lepore, 2013), 2) women with lower educational attainment (Joyce et al., 2000; Barrett et al., 2004; Kuroki et al., 2008; Dott et al., 2010; Postlethwaite et al., 2010; Maxson and Miranda, 2011; Nelson and Lepore, 2013; Wellings et al., 2013; Yanikkerem et al., 2013; Stern et al., 2016), 3) immigrant women (Joyce et al., 2000; Barrett et al., 2004; Mohllajee et al., 2007; Cheng et al., 2009; Xaverius et al., 2009; Dott et al., 2010; Postlethwaite et al., 2010; Maxson and Miranda, 2011; Mallard and Houghton, 2013; Nelson and Lepore, 2013), 4) younger women (Barrett et al., 2004; Han et al., 2005; Mohllajee et al., 2007; Kuroki et al., 2008; Cheng et al., 2009; Dott et al., 2010;

Postlethwaite et al., 2010; Maxson and Miranda, 2011; Takahashi et al., 2012; Mallard and Houghton, 2013; Wellings et al., 2013), 5) multiparous women (Mohllajee et al., 2007; Dott et al., 2010; Postlethwaite et al., 2010; Takahashi et al., 2012; Mallard and Houghton, 2013; Nelson and Lepore, 2013; Yanikkerem et al., 2013), 6) women having difficulty making ends meet (Joyce et al., 2000; Han et al., 2005; Maxson and Miranda, 2011; Takahashi et al., 2012; Mallard and Houghton, 2013; Stern et al., 2016), 7) women without a paid employment (Takahashi et al., 2012; Stern et al., 2016), and 8) those experiencing intimate partner violence (Pallitto et al., 2005; Sarkar, 2008; Miller et al., 2010; Azevêdo et al., 2013). Level of education was recoded as "low" (primary, secondary or post-secondary education) and "high" (college or university education). Ethnicity was based on country of birth of the parents, and a woman was classified as "immigrant" if one of her parents was born outside Belgium. Subjective poverty was based on the European Union – Statistics on Income and Living Conditions (EU-SILC), and was measured by asking, "How easy or difficult is it to make ends meet?" (easy, rather easy, rather difficult, difficult)(European Commission, 2010). For analyses, responses were recoded to easy/rather easy and difficult/rather difficult. Participants with a partner were asked to complete three items assessing physical, emotional, and sexual Intimate Partner Violence (IPV) that were based on a study by Galle and colleagues (Galle et al., 2015). Hypotheses were tested using the non-parametric Mann-Whitney U or Kruskal–Wallis test.

Exploratory Mokken analysis. In keeping with several previous evaluations of the LMUP (Morof et al., 2012; Borges et al., 2016), a Mokken scale analysis was conducted. Mokken scaling is a non-parametric method derived from Item Response Theory (IRT) and is a probabilistic version of Guttman scaling (Stewart et al., 2010; Watson et al., 2012). Mokken's model assumes the existence of an underlying construct (in this study pregnancy planning) which is captured by a homogenous set of items. Items vary in difficulty, and are hierarchically ordered by their degree of difficulty: people endorse an 'easier' item before they endorse a 'harder' or less popular item (Stewart et al., 2010; Watson et al., 2012). Loevinger's coefficient (H) is a parameter of the scalability, which is the extent to which items will be ordered hierarchically relative to one other based on their mean values. The fewer violations of Guttman ordering, the greater the scalability and the higher the H values (Watson et al., 2012). Items with a H value > 0.3 were eligible for scaling (Mokken, 1971; Sijtsma and Molenaar, 2002). The scalability of the full scale was also assessed, with H values < 0.4 indicating a 'weak' scale, 0.40 – 0.49 a 'medium' scale, and ≥ 0.50 a 'strong' scale (Mokken, 1971).

RESULTS

The socio-demographic characteristics of the 517 women in the sample are described in Table 1. The majority of the reproductive-aged women were multiparous, in a relationship, with a high educational background.

Table 1. Socio-demographic characteristics of the study participants (n=517)

Characteristic	M	SD
Age (years)	29.5	0.2
Characteristic	**n**	**%**
Gravida		
First pregnancy	201	39.0
Second or subsequent pregnancies	314	61.0
Parity		
First birth	247	48.0
Second or subsequent births	268	52.0
Nationality		
Belgian nationality	494	95.7
Other nationality	22	4.3
Ethnicity[a]		
Natives	455	88.5
Immigrants	59	11.5
Education[b]		
Low	19	3.7
Medium	181	35.3
High	313	61.0
Paid employment		
No	55	10.7
Yes	457	89.3
Monthly net household income		
< €2.000	44	8.8
€2.000 - €3.000	98	19.7
> €3.000	356	71.5
Subjective poverty		
Making ends meet with difficulty	74	14.7
Making ends meet easily	428	85.3
Partnership status		
Cohabiting with husband/partner	498	96.5
Not cohabiting with husband/partner	11	2.1
No current partner	7	1.4
Intimate partner violence (IPV)[c]	18	3.5

[a]One of the parents born outside; [b]Level of education: low=primary education, medium= secondary or post-secondary education, high=college or university education; [c]Physical, emotional or sexual IPV; Abbreviations: M, mean; SD, standard deviation.

Performance of the LMUP items

In general, the number of missing responses was very low (0.2% – 0.6%). Three participants (0.6%) had missing responses on one item, and one participant failed to respond to two items (0.2%). One participant had missing responses on four items (0.2%), and therefore, total LMUP score could not be calculated. Items with the most missing responses were item 5 (partner discussion) and item 1 (contraception)(Table 2).

Five items (contraception, timing, intention, desire, partner) had a response option with more than 80% endorsement: over 80% of the respondents did not use contraception when they became pregnant (item 1, category 2), wanted to become pregnant then or sooner (item 2, category 2), intended to become pregnant (item 3, category 2), wanted to have a baby when they became pregnant (item 4, category 2), and agreed with their partner to get pregnant (item 5, category 2). Few participants selected the first of the response options on these five items (Table 2).

Table 2. Endorsement frequencies of LMUP items and response options

Item	Category (score)	N	%
1. Contraception	0. Always using contraception (0)	11	2.1
	1. Using sometimes or failed at least once (1)	24	4.6
	2. Not using contraception (2)	480	92.8
	Missing data	2	0.4
2. Timing	0. Did not want pregnancy at all (0)	6	1.2
	1. Wanted pregnancy later (1)	38	7.4
	2. Wanted pregnancy then or sooner (2)	472	91.3
	Missing data	1	0.2
3. Intention	0. Did not intend pregnancy (0)	37	7.2
	1. Intentions kept changing (1)	20	3.9
	2. intended pregnancy (2)	459	88.8
	Missing data	1	0.2
4. Desire	0. Did not want baby (0)	9	1.7
	1. Mixed feelings about having baby (1)	39	7.5
	2. Wanted baby (2)	468	90.5
	Missing data	1	0.2
5. Partner	0. Never discussed getting pregnant (0)	7	1.4
	1. Discussed but did not agreed to get pregnant (1)	39	7.5
	2. Agreed to get pregnant (2)	468	90.5
	Missing data	3	0.6
6. Preparation	0. Did no preparatory lifestyle changes (0)	134	25.9
	1. Did 1 preparatory lifestyle change (1)	155	30.0
	2. Did 2 or more preparatory lifestyle changes (2)	184	43.9
	Missing data	1	0.2

The distribution of the total LMUP scores was strongly left-skewed (Fig 1). The median score was 11 (inter-quartile range 10–12), with 430 (83.3%) participants scoring 10–12 (planned); 77 (15.0%) scoring 4–9 (ambivalent); and 9 (1.7%) scoring 0–3 (unplanned).

The Dutch version of the LMUP scored 7.4 on the Flesch-Kincaid Grade Level score and rated 73% on the Flesch Reading Ease score, which both corresponds to a 7th grade reading level or a reading age of 12 years.

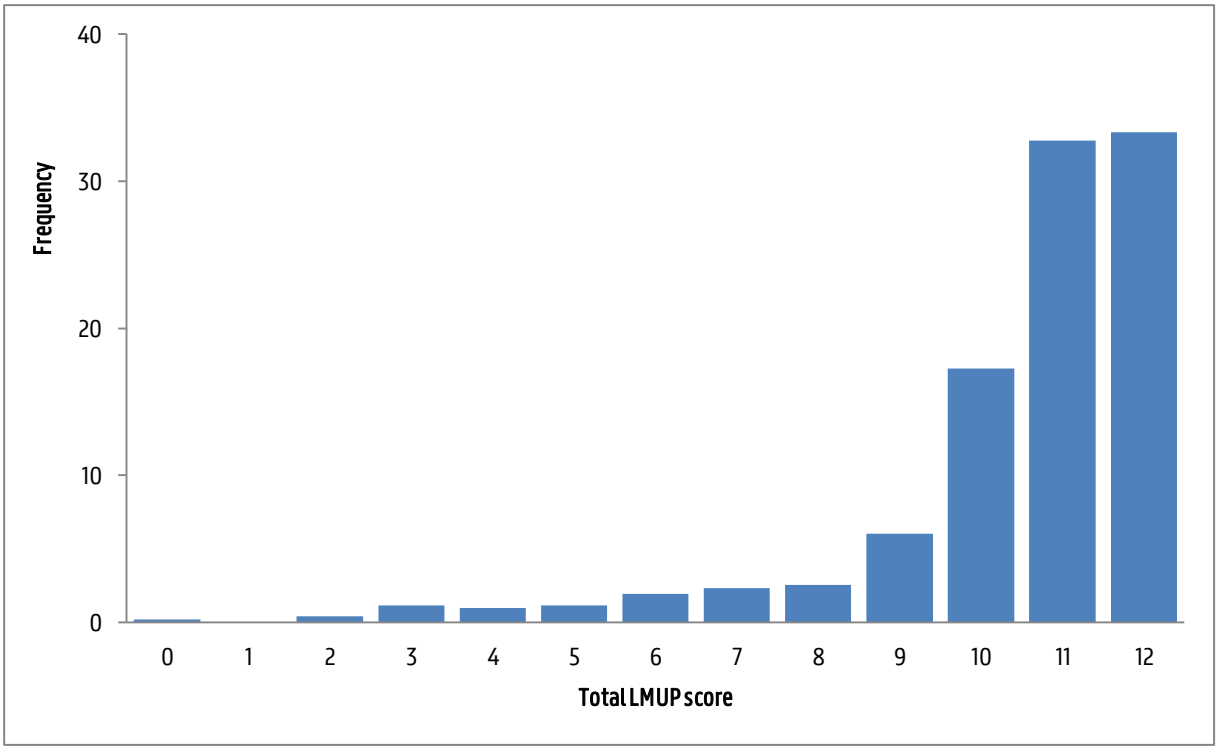

Fig 1. Distribution of Dutch London Measure of Unplanned Pregnancy (LMUP) scores.

Reliability of the LMUP

Alpha was 0.74 and all corrected item-total correlations were above 0.20 (item 1: 0.40, item 2: 0.57, item 3: 0.69, item 4: 0.59, item 5: 0.69, item 6: 0.32). All inter-item correlations were in the positive direction, and showed moderate and strong correlations between the items (range: 0.14 – 0.69).

Validity of the LMUP

Principal component analysis confirmed the one-dimensional structure of the scale (Eigenvalue = 3.17), with factor loadings above 0.45 on all items (item 1: 0.58, item 2: 0.76, item 3: 0.86, item 4: 0.78, item 5: 0.84, item 6: 0.45). All hypotheses were confirmed (Table 3).

Table 3. Construct validity hypothesis tests

Hypothesis	Variable	Score range (median)	P-value
Living with partner will be associated with higher scores, other categories with lower scores.[1-7]	<u>Partnership status:</u> Cohabiting with husband/partner Not cohabiting with husband/partner No current partner	 2 – 12 (11) 2 – 12 (9) 0 – 12 (8)	 0.001[a]
Higher educational status will be associated with higher scores.[5-14]	<u>Educational level:</u> None Primary Secondary Post-secondary College or university	 4 – 11 (10) 7 – 12 (11) 2 – 12 (11) 0 – 12 (11) 3 – 12 (11)	 < 0.001[a]

Natives will have the highest scores. [1-7,11,13,15]	Ethnicity Natives Immigrants	 0 – 12 (11) 3 – 12 (11)	 0.05 [b]
The youngest women will have the lowest scores. [1-4,6-8,11,12,16,17]	Age group < 20 20 – 24 25 – 29 30 – 34 35 – 39 40+	 7 – 9 (8) 0 – 12 (11) 5 – 12 (11) 2 – 12 (11) 3 – 12 (11) 8 – 12 (12)	 0.005[a]
Nulliparous women will have the highest scores. [2,4-6,9,11,16]	Number of children First child Second child Third or more child	 2 – 12 (11) 3 – 12 (10) 3 – 12 (10)	 <0.001[a]
Making ends meet easily will have the highest scores. [10,13,14,16-18]	Subjective poverty Making ends meet with difficulty Making ends meet easily	 2 – 12 (10) 0 – 12 (11)	 <0.001[b]
Paid employment will be associated with highest scores. [14,16]	Paid employment Yes No	 0 – 12 (11) 2 – 12 (11)	 0.001[b]
Intimate partner violence will be associated with lowest scores. [19-22]	Intimate partner violence Yes No	 0 – 12 (7.5) 2 – 12 (11)	 <0.001[b]

[a]Kruskal-Wallis tests; [b]Mann-Withney U tests; [1]Cheng et al. 2009; [2]Mallard et al. 2013; [3]Maxson et al. 2011; [4]Mohllajee et al. 2007; [5]Nelson et al. 2013; [6]Postlethwaite et al. 2010; [7]Barrett et al. 2004; [8]Wellings et al. 2013; [9]Yanikkerem et al. 2013; [10]Maxson et al. 2011; [11]Dott et al. 2010; [12]Kuroki et al. 2008; [13]Joyce et al. 2000; [14]Stern et al. 2016; [15]Xaverius et al. 2009; [16]Takahashi et al. 2012; [17]Han et al. 2005; [18]Mallard et al. 2013; [19]Azevêdo et al. 2013; [20]Miller et al. 2010; [21]Pallitto et al. 2005; [22]Sarkar 2008

Exploratory Mokken analysis

The Mokken scale analysis showed a hierarchical ordering of the items according to their difficulty, with item 2 (timing of motherhood) being the easiest to endorse, followed by items 5, 4, 1, 3, and 6 (preconceptual preparations) being the most difficult to endorse. All items were eligible for scaling (H > 0.3) and successfully formed a Guttman scale (H: item 1, 0.42; item 2, 0.54; item 3, 0.64; item 4: 0.55; item 5: 0.63; item 6: 0.58). The overall Loevinger's coefficient was 0.57, representing a 'strong' scale.

DISCUSSION

The objective of this study was to translate the London Measure of Unplanned Pregnancy (LMUP) into Dutch and to evaluate its psychometric properties in a sample of Dutch-speaking women giving birth recently.

Like the original LMUP (Barrett et al., 2004) and the other translated versions (Rocca et al., 2010; Morof et al., 2012; Hall et al., 2013; Borges et al., 2016; Habib et al., 2017), the Dutch version of the LMUP items had very low rates of missing data. The readability level was at 7th grade level, which is again in line with the original LMUP (6th – 7th grade) (Barrett et al., 2004) and the US English version (6th grade) (Morof et al., 2012). By contrast, the

Dutch version of the LMUP performed less well on the 80% endorsement criterion which gives an indication of item discrimination. The first of the three response options of item one to five (contraception, timing, intention, desire, partner) received very high response rates (89 – 93%). This can, however, be easily explained by the fact that our study population was homogeneous in terms of pregnancy outcome – that is, pregnancies ending in birth. It is not surprising that in a high-income country with easy access to (emergency) birth control and legal abortion, and a study population consisting of women with a continuing pregnancy, the proportion of planned pregnancies is higher compared to studies in low-income countries, countries with difficult access to (emergency) birth control or where abortion is illegal, and studies that included the abortion population. This also explains the high response rates to categories corresponding with a higher degree of pregnancy planning, and the reason why the distribution of the total LMUP scores was strongly left-skewed. It is surprising that item 6 did not show the same endorsement pattern as item one to five, i.e. a high proportion of women reporting two or more preconception lifestyle changes. However, similar as described in the Brazilian and Iranian study (Roshanaei et al., 2015; Borges et al., 2016), women in Belgium are not familiar with the concept of preconception health and care. To date, there is little experience with implementing preconception care initiatives in the Dutch-speaking part of Belgium. While this study on pregnancy planning was conducted, an evidence-based website on preconception care with a specific focus on folic acid intake was launched providing evidence-based information for both women and men planning a pregnancy, and healthcare providers (Delbaere et al., 2016). It is possible that the implementation of this website and other future preconception initiatives will lead to making more preconception lifestyle changes, and thus, higher responses to categories 2 and 3 of item 6.

Our findings support the reliability of the Dutch version of the LMUP. The internal consistency was acceptable with a Cronbach's alpha of 0.74, comparable to the versions in India, Malawi, and the US (α = 0.71–0.78) (Rocca et al., 2010; Morof et al., 2012; Hall et al., 2013), but lower than the original English measure (α = 0.92) (Barrett et al., 2004) and the Portuguese, Persian, Urdu, Arabic, and Spanish versions of the LMUP (α = 0.81–0.87) (Morof et al., 2012; Roshanaei et al., 2015; Borges et al., 2016; Almaghaslah et al., 2017; Habib et al., 2017).

Our results of the principal component analysis confirmed the unidimensionality of the LMUP, which provides evidence for the construct validity of the Dutch version of the LMUP. These findings are consistent with those reported from the original UK study (Barrett et al., 2004), and from Brazil (Borges et al., 2016), Pakistan (Habib et al., 2017), Saudi Arabia (Almaghaslah et al., 2017), and the United States (Morof et al., 2012). In addition, all hypotheses were confirmed, providing further support for the construct validity of the Dutch version of the LMUP.

The results of the Mokken analysis also confirmed that all six items contributed to the scale, which is consistent with findings of the Brazilian study (Borges et al., 2016). In comparison, the Mokken analysis of the US version of the LMUP indicated that the contraception item contributed only little to the scale (Morof et al., 2012). The US study was conducted in low-income women with a limited access to birth control. In contrast, Belgian women have an easy access to contraception (Gisle and Demarest, 2014), which might explain this difference.

This study has some limitations. First, due to time constraints, the WHO's process of translation and adaption of research instruments was not fully followed. There was no back-translation and external expert panel, and the pre-test consisted of only six, native women instead of the recommended minimum of 10. However, the women in the pre-test sample were from different age and socioeconomic groups, and during the last interviews no new information was obtained. In addition, the WHO guidelines are more stringent compared to other guidelines, such as the COSMIN standards for cross-cultural validity of a measure, of which most standards are met in this study (Mokkink et al., 2012). Another important limitation of our study is the lack of test-retest reliability data for the Dutch version of the LMUP. In addition, we did not include women with a pregnancy ending in abortion, which resulted in a homogeneous sample. Thus, the psychometric properties of the LMUP are unknown in the abortion population, and it is therefore important to confirm that the Dutch version of the LMUP is also valid for use among women with a pregnancy ending in abortion. Finally, higher educated and native-born women were overrepresented in our study compared to the general population of women giving birth in Flanders (Gillet et al., 2014). On the other hand, this study has several strengths, including a rigorous process of translation and adaption of the LMUP from English into Dutch, a large sample size, and a comprehensive database on several aspects of the pregnancy enabling hypothesis-testing. This was the first validation study that examined large number of hypotheses based on findings from the original UK study and existing literature to support the construct validity of the LMUP.

Future validation studies should include women during the first trimester of their pregnancy in order to include pregnancies ending in birth, as well as induced and spontaneous abortions. In addition, the test-retest reliability should be examined. The longer term stability of women's reported intentions, for instance between pregnancy and after birth, may also be assessed in future.

CONCLUSION

This study supports the reliability and validity of the Dutch version of the Belgian LMUP. The Dutch version of the LMUP measure can be used to study unplanned pregnancies in the Dutch-speaking population in Belgium as public health research on this topic is lacking in in Belgium. It would also be interesting to use the LMUP in

intervention development and evaluation regarding preconception care and the reduction of unplanned pregnancies (Frayne et al., 2016). Before an intervention can be developed, it is necessary to conduct a needs assessment and a problem analysis to understand the problem and to identify what needs to be changed (Bartholomew et al., 2011; World Health Organization, 2012). For example, the LMUP can be used to gain insight in the prevalence of planned and unplanned pregnancies, the associated factors and underlying processes, and the maternal and neonatal outcomes. These insights can contribute to the development of an intervention to increase the number of well-planned pregnancies. Future research, however, is necessary to assess the stability of the Dutch version of the LMUP, and to evaluate its psychometric properties in women with abortions.

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References

Azevêdo ACdC, Araújo TVBd, Valongueiro S, Ludermir AB (2013) Intimate partner violence and unintended pregnancy: prevalence and associated factors. Cadernos de saude publica 29: 2394-404.

Almaghaslah E, Rochat R, Farhat G (2017) Validation of a pregnancy planning measure for Arabic-speaking women. PloS one 12:e0185433.

Bachrach CA, Newcomer S (1999) Intended pregnancies and unintended pregnancies: distinct categories or opposite ends of a continuum? Family planning perspectives 31:251-252.

Barrett G, Wellings K (2002) What is a 'planned' pregnancy? Empirical data from a British study. Social science & medicine (1982) 55:545-557.

Barrett G, Smith SC, Wellings K (2004) Conceptualisation, development, and evaluation of a measure of unplanned pregnancy. J Epidemiol Community Health 58:426-433.

Bartholomew LK, Parcel GS, Kok G, Gottlieb NH, Fernandez ME (2011) Planning health promotion programs: an intervention mapping approach, third Edition: John Wiley & Sons.

Belgium NIoS- (2016) Statistieken en cijfers [statistics and numbers]. In: FOD Economie-Algemene Directie Statistiek.

Borges AL, Barrett G, dos Santos OA, de Castro Nascimento N, Cavalhieri FB, Fujimori E (2016) Evaluation of the psychometric properties of the London Measure of Unplanned Pregnancy in Brazilian Portuguese. BMC pregnancy and childbirth 16:244.

Borrero S, Nikolajski C, Steinberg JR, Freedman L, Akers AY, Ibrahim S, Schwarz EB (2015) "It just happens": a qualitative study exploring low-income women's perspectives on pregnancy intention and planning. Contraception 91:150-156.

Campbell AA, Mosher WD (2000) A history of the measurement of unintended pregnancies and births. Matern Child Health J 4:163-169.

CDC/National Center for Health Statistics (2016) 2013-2015 National Survey of Family Growth - FEMALE Questionnaire. In. USA: CDC/National Center for Health Statistics.

Chandra A, Martinez GM, Mosher WD, Abma JC, Jones J (2005) Fertility, family planning, and reproductive health of US women: data from the 2002 National Survey of Family Growth. Vital and health statistics Series 23, Data from the National Survey of Family Growth:1-160.

Cheng D, Schwarz EB, Douglas E, Horon I (2009) Unintended pregnancy and associated maternal preconception, prenatal and postpartum behaviors. Contraception 79:194-198.

Delbaere I, Mokangi P, Roelens K, De Sutter A, Gellynck X, Beeckman D, van de Walle L, Vandenbulcke P, De Steur H (2016) Systematic development of an evidence-based website on preconception care. Ups J Med Sci:1-7.

Devlieger R, Martens E, Martens G, Van Mol C, Cammu H (2016) Perinatale activiteiten in Vlaanderen 2015 [Perinatal activities in Flanders 2015]. In. Brussels: SPE.

Dibaba Y, Fantahun M, Hindin MJ (2013) The effects of pregnancy intention on the use of antenatal care services: systematic review and meta-analysis. Reproductive health 10:50.

DiCenso A, Guyatt G, Willan A, Griffith L (2002) Interventions to reduce unintended pregnancies among adolescents: systematic review of randomised controlled trials. Bmj 324:1426.

Dott M, Rasmussen SA, Hogue CJ, Reefhuis J (2010) Association between pregnancy intention and reproductive-health related behaviors before and after pregnancy recognition, National Birth Defects Prevention Study, 1997-2002. Matern Child Health J 14:373-381.

Elaut E, Buysse A, Caen M, Vandamme J, Vermeire K, T'Sjoen G (2015) Contraceptive use in Flanders (Belgium): A comparison between a general population sample and a Turkish ethnic minority sample. The European journal of contraception & reproductive health care : the official journal of the European Society of Contraception 20:283-295.

European Commission (2010) Income and living conditions in Europe In. Luxembourg.

Federal Public Service for Foreign Affairs FTaDC (2015) Belgium at a glance. In. Brussels.

Fischer RC, Stanford JB, Jameson P, DeWitt MJ (1999) Exploring the concepts of intended, planned, and wanted pregnancy. The Journal of family practice 48:117-122.

Frayne DJ, Verbiest S, Chelmow D, Clarke H, Dunlop A, Hosmer J, Menard MK, Moos MK, Ramos D, Stuebe A, Zephyrin L (2016) Health Care System Measures to Advance Preconception Wellness: Consensus Recommendations of the Clinical Workgroup of the National Preconception Health and Health Care Initiative. Obstet Gynecol 127:863-872.

Galle A, Van Parys AS, Roelens K, Keygnaert I (2015) Expectations and satisfaction with antenatal care among pregnant women with a focus on vulnerable groups: a descriptive study in Ghent. BMC women's health 15:112.

Gillet E, Saerens B, Martens G, Cammu H (2014) Fetal and infant health outcomes among immigrant mothers in Flanders, Belgium. International journal of gynaecology and obstetrics: the official organ of the International Federation of Gynaecology and Obstetrics 124:128-133.

Gipson JD, Koenig MA, Hindin MJ (2008) The effects of unintended pregnancy on infant, child, and parental health: a review of the literature. Studies in family planning 39:18-38.

Gisle L, Demarest S (2014) Gezondheidsenquête door interview, België, 2004 [Health interview survey, Belgium, 2004] In. Brussels: Wetenschappelijk Instituut Volksgezondheid, Afdeling Epidemiologie

Goossens J, Van Den Branden Y, Van der Sluys L, Delbaere I, Van Hecke A, Verhaeghe S, Beeckman D (2016) The prevalence of unplanned pregnancy ending in birth, associated factors, and health outcomes. Hum Reprod 31:2821-2833.

Habib MA, Raynes-Greenow C, Nausheen S, Soofi SB, Sajid M, Bhutta ZA, Black KI (2017) Prevalence and determinants of unintended pregnancies amongst women attending antenatal clinics in Pakistan. BMC pregnancy and childbirth 17:156.

Hall J, Benton L, Copas A, Stephenson J (2017a) Pregnancy Intention and Pregnancy Outcome: Systematic Review and Meta-Analysis. Maternal and Child Health Journal:1-35.

Hall J, Barrett G, Copas A, Stephenson J (2017b) London measure of Unplanned Pregnancy: guidance for its use as an outcome measure. Patient Related Outcome Measures.

Hall J, Barrett G, Mbwana N, Copas A, Malata A, Stephenson J (2013) Understanding pregnancy planning in a low-income country setting: validation of the London measure of unplanned pregnancy in Malawi. BMC pregnancy and childbirth 13:200.

Han JY, Nava-Ocampo AA, Koren G (2005) Unintended pregnancies and exposure to potential human teratogens. Birth defects research Part A, Clinical and molecular teratology 73: 245-248.

Higgins JA, Popkin RA, Santelli JS (2012) Pregnancy ambivalence and contraceptive use among young adults in the United States. Perspectives on sexual and reproductive health 44:236-243.

Jack BW, Atrash H, Coonrod DV, Moos MK, O'Donnell J, Johnson K (2008) The clinical content of preconception care: an overview and preparation of this supplement. Am J Obstet Gynecol 199:S266-279.

Joyce TJ, Kaestner R, Korenman S (2000). The effect of pregnancy intention on child development. Demography 37: 83-94.

Kincaid JP, Fishburne Jr RP, Rogers RL, Chissom BS (1975) Derivation of new readability formulas (automated readability index, fog count and flesch reading ease formula) for navy enlisted personnel. In: DTIC Document.

Klerman LV (2000) The Intendedness of Pregnancy: A Concept in Transition. Maternal and Child Health Journal 4:155-162.

Kuroki LM, Allsworth JE, Redding CA, Blume JD, Peipert JF (2008). Is a previous unplanned pregnancy a risk factor for a subsequent unplanned pregnancy? American journal of obstetrics and gynecology 199: 1-7.

Lassi ZS, Imam AM, Dean SV, Bhutta ZA (2014) Preconception care: caffeine, smoking, alcohol, drugs and other environmental chemical/radiation exposure. Reprod Health 11 Suppl 3:S6.

Mallard SR, Houghton LA (2013) Socio-demographic characteristics associated with unplanned pregnancy in New Zealand: implications for access to preconception healthcare. The Australian & New Zealand journal of obstetrics & gynaecology 53:498-501.

Maxson P, Miranda ML (2011) Pregnancy intention, demographic differences, and psychosocial health. Journal of women's health (2002) 20:1215-1223.

Miller E, Decker MR, McCauley HL, et al. (2010) Pregnancy coercion, intimate partner violence and unintended pregnancy. Contraception 81: 316-322.

Mohllajee AP, Curtis KM, Morrow B, Marchbanks PA (2007) Pregnancy intention and its relationship to birth and maternal outcomes. Obstetrics and gynecology 109:678-686.

Mokken RJ (1971) A theory and procedure of scale analysis: With applications in political research: Walter de Gruyter.

Mokkink LB, Terwee CB, Patrick DL, Alonso J, Stratford PW, Knol DL, Bouter LM, de Vet HC (2012) COSMIN checklist manual. Amsterdam: University Medical Center.

Morof D, Steinauer J, Haider S, Liu S, Darney P, Barrett G (2012) Evaluation of the London Measure of Unplanned Pregnancy in a United States population of women. PLoS One 7:e35381.

Nelson DB, Lepore SJ (2013) The role of stress, depression, and violence on unintended pregnancy among young urban women. Journal of women's health (2002) 22:673-680.

Pallitto CC, Campbell JC, O'Campo P (2005) Is intimate partner violence associated with unintended pregnancy? A review of the literature. Trauma, Violence, & Abuse 6: 217-235.

Petersen R, Moos MK (1997) Defining and measuring unintended pregnancy: issues and concerns. Women's health issues : official publication of the Jacobs Institute of Women's Health 7:234-240.

Polit DF, Beck CT (2010) Essentials of Nursing Research: Appraising Evidence for Nursing Practice: Wolters Kluwer Health / Lippincott Williams & Wilkins.

Postlethwaite D, Armstrong MA, Hung YY, Shaber R (2010) Pregnancy outcomes by pregnancy intention in a managed care setting. Matern Child Health J 14:227-234.

Rocca CH, Krishnan S, Barrett G, Wilson M (2010) Measuring pregnancy planning: An assessment of the London Measure of Unplanned Pregnancy among urban, south Indian women. Demographic research 23:293-334.

Roshanaei S, Shaghaghi A, Jafarabadi MA, Kousha A (2015) Measuring unintended pregnancies in postpartum Iranian women: validation of the London Measure of Unplanned Pregnancy. Eastern Mediterranean health journal 21:572-578.

Santelli J, Rochat R, Hatfield-Timajchy K, Gilbert BC, Curtis K, Cabral R, Hirsch JS, Schieve L (2003) The measurement and meaning of unintended pregnancy. Perspectives on sexual and reproductive health 35:94-101.

Sarkar N (2008) The impact of intimate partner violence on women's reproductive health and pregnancy outcome. Journal of Obstetrics and Gynaecology 28: 266-271.

Schwarz EB, Lohr PA, Gold MA, Gerbert B (2007) Prevalence and correlates of ambivalence towards pregnancy among nonpregnant women. Contraception 75:305-310.

Secura GM, Allsworth JE, Madden T, Mullersman JL, Peipert JF (2010) The Contraceptive CHOICE Project: Reducing Barriers to Long-Acting Reversible Contraception. American journal of obstetrics and gynecology 203:115.e111-117.

Sedgh G, Singh S, Henshaw SK, Bankole A (2011) Legal abortion worldwide in 2008: levels and recent trends. International perspectives on sexual and reproductive health 37:84-94.

Shah PS, Balkhair T, Ohlsson A, Beyene J, Scott F, Frick C (2011) Intention to become pregnant and low birth weight and preterm birth: a systematic review. Matern Child Health J 15:205-216.

Sijtsma K, Molenaar IW (2002) Introduction to nonparametric item response theory: Sage.

Stanford JB, Hobbs R, Jameson P, DeWitt MJ, Fischer RC (2000) Defining Dimensions of Pregnancy Intendedness. Maternal and Child Health Journal 4:183-189.

Stern J, Joelsson LS, Tyden T, et al. (2016) Is pregnancy planning associated with background characteristics and pregnancy-planning behavior? Acta Obstet Gynecol Scand 95: 182-189.

Stewart ME, Watson R, Clark A, Ebmeier KP, Deary IJ (2010) A hierarchy of happiness? Mokken scaling analysis of the Oxford Happiness Inventory. Personality and Individual Differences 48:845-848.

Streiner DL, Norman GR, Cairney J (2014) Health measurement scales: a practical guide to their development and use, 5th Edition: Oxford University Press, USA.

Takahashi S, Tsuchiya KJ, Matsumoto K, Suzuki K, Mori N, Takei N (2012) Psychosocial factors of mistimed and unwanted pregnancy: the Hamamatsu Birth Cohort (HBC) study. Maternal and Child Health Journal 16: 947-55.

Temel S, van Voorst SF, de Jong-Potjer LC, Waelput AJ, Cornel MC, de Weerd SR, Denktaş S, Steegers EA (2015) The Dutch national summit on preconception care: a summary of definitions, evidence and recommendations. Journal of community genetics 6:107.

Trussell J, Vaughan B, Stanford J (1999) Are all contraceptive failures unintended pregnancies? Evidence from the 1995 National Survey of Family Growth. Family planning perspectives 31:246-247, 260.

Trussell J, Stewart F, Guest F, Hatcher RA (1992) Emergency contraceptive pills: a simple proposal to reduce unintended pregnancies. Family planning perspectives 24:269-273.

United Nations (2015) The Millennium Development Goals Report 2015. In.

U.S. Department of Health and Human Services (1990) Healthy People 2000: National Health Promotion and Disease Prevention Objectives. In. Washington (DC): Public Health Service

U.S. Department of Health and Human Services (2010) Healthy People 2020: National Health Promotion and Disease Prevention Objectives. Maternal, Infant, and Child Health : Preconception Health and Behaviors. In: Healthy People 2020.

Van Bavel J, Nomes E (2016) De recente evolutie van de vruchtbaarheid in het Vlaamse Gewest: 2014 - 2015 [The recent evolution of fertility in Flanders: 2014 - 2015] In. Leuven: Centrum voor Sociologisch Onderzoek - KU Leuven.

Watson R, van der Ark LA, Lin LC, Fieo R, Deary IJ, Meijer RR (2012) Item response theory: how Mokken scaling can be used in clinical practice. Journal of clinical nursing 21:2736-2746.

Wellings K, Jones KG, Mercer CH, et al. (2013) The prevalence of unplanned pregnancy and associated factors in Britain: findings from the third National Survey of Sexual Attitudes and Lifestyles (Natsal-3). Lancet 382: 1807-16.

World Health Organization (2009) Management of substance abuse: Process of translation and adaptation of instruments. In: WHO.

World Health Organization (2010) Packages of interventions for family planning, safe abortion care, maternal, newborn and child health. In: WHO.

World Health Organization (2012) Meeting to Develop a Global Consensus on Preconception Care to Reduce Maternal and Childhood Mortality and Morbidity. In. Geneva: World Health Organization Headquarters.

Xaverius PK, Tenkku LE, Salas J (2009) Differences between women at higher and lower risk for an unintended pregnancy. Women's health issues : official publication of the Jacobs Institute of Women's Health 19: 306-312.

Yanikkerem E, Ay S, Piro N (2013). Planned and unplanned pregnancy: effects on health practice and depression during pregnancy. The journal of obstetrics and gynaecology research 39: 180-187.

SI 1 Instrument. The Dutch version of the London Measure of Unplanned Pregnancies.

Hieronder vind je enkele vragen die peilen naar je situatie en gevoelens in de periode waarin je zwanger werd. Denk aan jouw meest recente zwangerschap bij het beantwoorden van de vragen.

1. **In de maand dat ik zwanger werd…** *(duid aan welke stelling het best bij je past):*
   - o Gebruikte ik/wij geen voorbehoedsmiddelen
   - o Gebruikte ik/wij voorbehoedsmiddelen, maar niet altijd
   - o Gebruikte ik/wij altijd voorbehoedsmiddelen, maar weet ik dat de methode minstens eenmaal heeft gefaald (vb. verschoven, werkte niet, …)
   - o Gebruikte ik/wij altijd voorbehoedsmiddelen

2. **In termen van 'moeder worden' (eerste keer of opnieuw), heb ik het gevoel dat mijn zwangerschap plaatsvond op een…** *(duid aan welke stelling het best bij je past):*
   - o Juist moment
   - o Ok, maar niet echt het juist moment
   - o Verkeerd moment

3. **Net vóór ik zwanger werd…** *(duid aan welke stelling het best bij je past):*
   - o Was ik van plan om zwanger te worden
   - o Veranderden mijn plannen om zwanger te worden voortdurend
   - o Was ik niet van plan om zwanger te worden

4. **Net vóór ik zwanger werd…** *(duid aan welke stelling het best bij je past):*
   - o Wilde ik een baby krijgen
   - o Had ik gemengde gevoelens over het krijgen van een baby
   - o Wilde ik geen baby krijgen

De volgende vraag heeft betrekking op je partner – dit is (of was) mogelijks je echtgenoot, een partner waarmee je samenleeft, een vriendje, of iemand waar je één of twee keer seksuele betrekking mee had.

5. **Vóór ik zwanger werd…** *(duid aan welke stelling het best bij je past):*
   - o Waren mijn partner en ik het erover eens dat we zwanger wilden worden
   - o Hadden mijn partner en ik het samen krijgen van kinderen besproken, maar waren we niet overeengekomen om zwanger te worden
   - o Hadden mijn partner en ik het samen krijgen van kinderen nooit besproken

6. **Vóór je zwanger werd, heb je iets gedaan om je gezondheid te bevorderen als voorbereiding op de zwangerschap?** (*Er zijn meerdere antwoorden mogelijk)*
   - ❑ Ik nam foliumzuur
   - ❑ Ik ben gestopt of verminderd met roken
   - ❑ Ik ben gestopt of verminderd met het drinken van alcohol
   - ❑ Ik at gezonder
   - ❑ Ik zocht medisch/gezondheid advies
   - ❑ Ik ondernam een andere actie, gelieve te omschrijven:……
     of
   - ❑ Ik ondernam niets van bovenstaande acties vóór mijn zwangerschap

CHAPTER 4

THE PREVALENCE OF UNPLANNED PREGNANCY ENDING IN BIRTH, ASSOCIATED FACTORS, AND HEALTH OUTCOMES

Based on the article of Goossens, J., Van Den Branden, Y., Van der Sluys, L., Delbaere, I., Van Hecke, A., Verhaeghe, S., Beeckman, D. (2016). The prevalence of unplanned pregnancy ending in birth, associated factors, and health outcomes. Human Reproduction 31, 2821 – 2833. dio: 10.1093/humrep/dew266. Category OBSTETRICS & GYNECOLOGY: 5/79 (Q1) – IF: 5.020.

ABSTRACT

Study question: What are associated factors of unplanned pregnancies ending in birth?

Summary answer: Pregnancies that were less planned were associated with women of lower socio-economic status (SES), and an unhealthier lifestyle before and during the pregnancy, more stress, and less social support.

What is known already: In Europe, the prevalence of unplanned pregnancy leading to birth varies. Unplanned pregnancy is more common among socially disadvantaged women, and associated with adverse pregnancy outcomes.

Study design, size, duration: In a cross-sectional study, 517 women were recruited from May through September 2015.

Participants, materials, setting, methods: Women were recruited from six hospitals in Flanders, Belgium. Data from self-report and medical records were collected during the first 5 days postpartum. The validated London Measure of Unplanned Pregnancy was used to collect data regarding pregnancy planning. Data were analyzed with Mann-Whitney U tests, Kruskal-Wallis tests, and multiple linear regression analysis.

Main results and the role of chance: The majority of the pregnancies (83%) ending in birth were planned, 15% were ambivalent, and 2% unplanned. Women who are multigravida (95% CI -0.30 – -0.02), less well educated (95% CI 0.07 – 0.85), single or having a non-cohabiting relationship (95% CI 0.01 – 2.53), having history of drug abuse (95% CI -2.07 – -0.35), and experiencing intimate partner violence (95% CI -3.82 – -1.59) tended to have a significantly higher risk of a less planned pregnancy. Less planned pregnancies were significantly associated with initially unwanted pregnancies ($p<0.001$), no folic acid or vitamin use before pregnancy ($p<0.001$), lower number of prenatal visits ($p=0.03$), smoking during pregnancy ($p<0.001$), more stress ($p=0.002$), lower relationship satisfaction ($p=0.001$), and less social support ($p<0.001$). Less planned pregnancies were also significantly associated with hyperemesis ($p<0.001$) and shorter duration of delivery ($p=0.03$). No differences were found in neonatal outcomes.

Limitations, reasons for caution: The prevalence of unplanned pregnancies is probably underestimated due to overrepresentation of women with higher SES in this study. Women's emotions may have influenced the answer to certain questions. Owing to the cross-sectional design, no causal relationships could be established.

Wider implications of the findings: This study emphasizes the importance of targeting socially disadvantaged women in the prevention of unplanned pregnancies.

Study funding/competing interest(s): This study was funded by the Research Foundation – Flanders (FWO). The authors have no conflict of interests.

Trial registration number: Not applicable

Keywords: Pregnancy, unplanned pregnancy, planned pregnancy, prevalence, risk factors, pregnancy outcome, women, newborn infant, reproductive health, reproductive behavior

INTRODUCTION

Worldwide, 40% of all pregnancies were unintended in 2012, of which 62% ended in abortion and 38% in birth. The proportion of pregnancies that were unintended in Europe was 45%, and one fourth of these pregnancies were continued (Sedgh et al., 2014). Estimates of unintended and unplanned pregnancies (see below) ending in birth varied between other European studies. For example, in six European countries (Belgium, Iceland, Denmark, Estonia, Norway, Sweden) 19% of the pregnancies were estimated as unintended (Lukasse et al., 2015), 12% in Sweden (Stern et al., 2016), and 22% in Spain (Font-Ribera et al., 2008). These differences can partly be explained by a variation in definition. Although terms referring to intendedness, wantedness, timing and planning status of a pregnancy are often used interchangeably, a clear distinction should be made (Petersen and Moos, 1997; Klerman, 2000). Intendedness is a construct based on questions about wantedness and timing of the pregnancy. Unintended pregnancies include unwanted and mistimed pregnancies (Klerman, 2000). Previous research suggests that women do not differentiate between the terms 'planning' and 'intending' a pregnancy, so these terms are used as synonyms (Barret and Wellings, 2002; Rocca et al., 2010). A pregnancy is considered as "unwanted" if a woman states she did not want to have (more) children for the rest of her life. If a woman states her pregnancy came sooner than wanted, it is classified as "mistimed" (Klerman, 2000).

Most unintended/ unplanned pregnancies are the result of inconsistent, incorrect or nonuse of contraception (Frost et al., 2007). Several factors may have an influence on contraceptive behavior including access to contraceptives, side effects, knowledge, openness and embarrassment, partner influences, risk perception, and locus of control (Pratt et al., 2014). Moreover, a growing number of studies associate inadequate use of contraceptives with pregnancy ambivalence – that is having conflicting attitudes, beliefs, emotions, or behaviors regarding avoiding pregnancy (Schwarz et al., 2007; Higgins et al., 2012). Yet, ambivalence towards pregnancy is insufficiently captured in quantitative research as most traditional instruments measure pregnancy intention/planning in a dichotomous manner, namely planned/ unplanned and intended/ unintended pregnancy (Santelli et al., 2003). Findings of Stanford et al. (2000) suggest a continuum with an affective dimension (desire for pregnancy) and a planning dimension including preconception health behavior and wider lifestyle preparations (such as finishing school).

Unintended/ unplanned pregnancies are associated with induced abortion, delayed initiation of antenatal care and less antenatal care visits, unhealthy behavior during pregnancy, increased risk of adverse birth outcomes

and neonatal health, development delay, and impaired psychosocial maternal health (Gipson et al., 2008; Abajobir et al., 2016). Other studies found no effect of pregnancy intention or planning on neonatal or maternal outcomes (Gipson et al., 2008).

The reduction of unintended/unplanned pregnancies is a key goal of global and national public health organizations (U.S. Department of Health and Human Services, 2010; United Nations, 2015). Before interventions can be developed, it is important to examine associated factors of unplanned pregnancies. Previously published studies on associated factors of pregnancy planning are inconsistent. Several studies found that women with unintended or unplanned pregnancy were more likely to be single or unmarried, younger, of non-Caucasian origin, have a higher parity, and lower socio-economic status (SES) (Maxson and Miranda, 2011; Mallard and Houghton, 2013; Nelson and Lepore, 2013). However, other studies found no or contrasting associations between women's demographics and unintended or unplanned pregnancy (Takahashi et al., 2012; Nelson and Lepore, 2013; Yanikkerem et al., 2013).

Although extensive research has been carried out on the prevalence, associated factors, and outcome of unintended and unplanned pregnancies, findings are inconclusive due to methodological and analytical concerns. Pregnancy planning and intention are being analyzed as categorical variables leading to oversimplification of a complex construct. Moreover, most studies focused only on the prevalence, and on only one aspect of unintended or unplanned pregnancies such as associated factors or a specific outcome. To the authors' knowledge, this is one of the first studies to investigate the prevalence, associated background factors, and pregnancy outcomes of unplanned pregnancies ending in birth in rigorous manner, with pregnancy planning analyzed as a continuous variable.

MATERIALS AND METHODS

Study design and sample

A cross-sectional study design with consecutive sampling was used to recruit women from six hospitals in Flanders, Belgium. Women were eligible to participate if they were between 15 and 45 years old, able to read Dutch, and admitted to the postnatal maternity ward of one of the participating hospitals.

Measurement

The development of the questionnaire was based on an extensive literature review on pregnancy intention and planning. Where possible, we used pre-existing surveys that were translated according to the World Health Organization (WHO) process of translation and adoption of research instruments (World Health Organization, 2009). The overall scale was reviewed by a panel of seven national experts who had expertise regarding

pregnancy planning to assess the overall content validity of the instrument (one general practitioner; one midwife with a master in nursing and midwifery and a master thesis regarding pregnancy planning; one midwife / sexologist conducting a PhD study on pregnancy and intimate partner violence; one clinical psychologist conducting a PhD study on abortion in Flanders; one policy advisor 'prevention of unplanned pregnancies' at the Flemish Centre for Sexual Health; one policy advisor at an information and support center on pregnancy choices ('FARA'); and one gynecologist. After the second round, the scale was judged to have excellent content validity, with a content validity index ≥ 0.88 (Polit and Beck, 2010). The next step comprised a pilot test using cognitive face-to-face interviews to evaluate the comprehensibility, the readability, and the acceptability of the items and response options. A sample of 6 women who met the inclusion criteria were included in the pre-test. These women had a mean age of 28.5 years with a range of 22 to 31 years. Most of them were low (n=1) or medium educated (n=3), and two women had college or university education. No immigrant women were interviewed.

Prevalence of unplanned pregnancy

Pregnancy planning: The London Measure of Unplanned Pregnancy (LMUP) was used to measure the prevalence of unplanned pregnancies. The LMUP does not assume that women have clearly defined pregnancy intentions, allowing them to express ambivalence towards becoming pregnant. The measure contains six items asking about contraceptive use, preconceptional preparations, partner influences, personal circumstances and timing, desire for pregnancy and motherhood, and intention to become pregnant. Each item is scored 0 to 2, with a total score ranging from 0 to 12; the higher the score, the more a pregnancy is planned/ intended. For prevalence estimates, the authors suggest a division of scores into a minimum of three groups, with scores 0–3 categorized as "unplanned", 4–9 as "ambivalent", and 10–12 as "planned". A recent study of Hall et al. (2017) suggests using the continuous score on the LMUP for inferential statistics. The LMUP has been assessed as valid and reliable (Cronbach's α = 0.92, test–retest = 0.97) (Barrett et al., 2004).

Associated background factors

Demographics: Information on socio-demographic factors included age, nationality, ethnicity, religion, education, occupation, living situation, net household income, household subjective poverty, marital status and length of the relationship, occupation and education of the partner. *Relationship satisfaction and intimate partner violence (IPV):* Participants with a partner were asked, "How happy are you in the relationship with your partner?" (very unhappy/ unhappy/ neutral/ happy/ very happy). IPV was assessed using three questions based on research by Galle et al. (2015) to capture physical, emotional and sexual abuse.

Pregnancy outcomes

Feelings about the current pregnancy: Participants were asked, "My current pregnancy was…" (wanted/ first unwanted, but later wanted/ unwanted/ first wanted, but later unwanted). *Lifestyle behavior:* Preconception health behavior was measured by an item from the LMUP, "Before you became pregnant, did you do anything to improve your health in preparation for pregnancy?". Information on lifestyle behavior included items on smoking, second-hand smoking, drug and alcohol use. *Stress:* The Perceived Stress Scale (PSS) was used to measure the degree to which life situations in the last month were appraised as stressful (Cohen et al., 1983). Total PSS scores range between 0 and 40, with a higher score indicating a higher level of perceived stress. The PSS has been assessed as valid and reliable (Cronbach's α = 0.71–0.93, test–retest = 0.74–0.88) (Lee, 2012). *Social support:* The Multidimensional Scale of Perceived Social Support (MSPSS) was used to measure perceived social support from family, friends, and a significant other. The total MSPSS score ranges between 12 and 84, with a higher score indicating a higher level of perceived social support. The MSPSS has been assessed as valid and reliable (Cronbach's α= 0.84 – 0.92, test-retest: 0.85) (Zimet et al., 1988). Information on maternal and neonatal health outcomes was obtained from medical records and included medical history, obstetric history, course of gestation, course of labor and delivery, and course of postpartum.

Procedure

Women were approached during the first 5 days postpartum. The study was explained by the head or study midwife of each postnatal maternity ward as a study on preparations before pregnancy. Women who agreed to participate completed the questionnaire, and returned it to a midwife in a closed envelope. After receiving the questionnaire and written informed consent, two junior researchers (qualified midwives and Master students in midwifery) collected data from the patient's medical records. The collected data were anonymised before being processed.

Participants were recruited from May through September 2015. Ethical approval for the study was obtained from Ghent University Hospital Ethics Committee (B670201524084 & B670201524085) and from local ethical committees of all participating hospitals.

Statistical analysis

A post-hoc power calculation was performed based on the measured prevalence of unplanned pregnancy (1.7%), and revealed a power of 0.99, with α = 0.05 and half-width of the CI = 0.015 (SAS Institute Inc., Cary, NC, USA). The Statistical Package for the Social Sciences (SPSS) version 21 was used for data analysis (IBM Corporation, Armonk, NY, USA). A value of $p<0.05$ was considered statistically significant. Descriptive analyses

were performed by using frequencies (percentages) for categorical variables and means (ranges) for continuous variables.

For prevalence estimates, the LMUP scores were divided into three groups, with scores 0–3 categorized as "unplanned", 4–9 as "ambivalent", and 10–12 as "planned".

The LMUP was treated as a continuous variable in further analyses (Hall et al., 2017), and thus, the lower the score on LMUP, the less planned a pregnancy was. The LMUP was not normally distributed, therefore, non-parametric tests were used. Spearman rank correlation coefficient was performed to analyze correlations between LMUP scores and continuous background characteristics. Mann-Whitney U tests and Kruskal-Wallis tests were used to compare differences in LMUP across categorical background characteristics . A multiple linear regression analysis was performed to identify which women had an increased risk of unplanned pregnancy using the "enter method" to obtain the best-fit model (Hall et al., 2017). The model included socio-demographic and health background characteristics found to be significant during simple regression analysis. The data were checked for multicollinearity using tolerance values and a variance inflation factor. The variables "gravity" and "parity" had a tolerance lower than 0.4, indicating some collinearity between the two variables (Chan, 2004). As a result, only "gravidity" was selected for use in the regression model.

Spearman rank correlation coefficient was performed to analyze correlations between LMUP scores and continuous pregnancy outcomes. Mann-Whitney U tests and Kruskal-Wallis tests were used to compare differences in LMUP across categorical pregnancy outcomes. Multiple linear regression analyses were not performed due to missing data.

RESULTS

Of the 2,390 women eligible to participate (based on total deliveries during study time in participating hospitals and nationality data), 517 women (22%) completed the questionnaire and informed consent form. Socio-demographic and antenatal characteristics are presented in Tables 1 and 2.

Table 1. Socio-demographic characteristics of women in a study of the prevalence of unplanned pregnancy ending in birth

Characteristic	Mean (SD)	Range	*p*-value	*rho*-value
Age (years, n=517)	29.5 (0.2)	17.0 – 41.0	0.08[a]	0.08
Perceived stress (n=484)	15.1 (5.7)	1.0 – 30.0	0.002[a]	-0.14
Relation duration (years, n=484)	8.0 (3.9)	0.8 – 20.0	0.39[a]	0.04
Relation satisfaction (n=506)	4.7 (0.9)	1.0 – 5.0	0.001[a]	0.15

Characteristic	n (%)	LMUP score*	*p*-value
Nationality			
Belgian nationality	494 (95.7)	11.0 [2.0]	0.50[b]
Other nationality	22 (4.3)	11.0 [1.3]	
Ethnicity			
Natives	455 (88.5)	11.0 [2.0]	0.04[b]
Immigrants[1]	59 (11.5)	11.0 [2.0]	
Education[2]			
Low	19 (3.7)	10.0 [2.0]	<0.001[c]
Medium	181(35.3)	11.0 [2.8]	
High	313 (61.0)	11.0 [2.0]	
Paid employment			
No	55 (10.7)	11.0 [2.0]	0.001[b]
Yes	457 (89.3)	11.0 [2.0]	
Net household income			
< €2.000	44 (8.8)	11.0 [3.0]	0.009[c]
€2.000 - €3.000	98 (19.7)	11.0 [2.0]	
> €3.000	356 (71.5)	11.0 [2.0]	
Household subjective poverty			
Difficult to make ends meet	74 (14.7)	10.0 [2.3]	<0.001[b]
Easy to make ends meet	428 (85.3)	11.0 [2.0]	
Social support			
Low support	7 (1.4)	5.0 [7.0]	<0.001[c]
Moderate support	173 (33.8)	11.0 [2.8]	
High support	332 (64.8)	11.0 [2.0]	
Marital status			
Cohabiting relationship	498 (96.5)	11.0 [2.0]	0.003[c]
Non-cohabiting relationship	11 (2.1)	9.0 [6.0]	
Single	7 (1.4)	8.0 [5.0]	
Education of partner			
Low	33 (6.8)	11.0 [2.5]	0.001[c]
Medium	252 (51.6)	11.0 [2.0]	
High	203 (41.6)	11.0 [1.0]	
Paid employment partner			
No	15 (3.0)	11.0 [3.0]	0.10[b]
Yes	477 (97.0)	11.0 [2.0]	
Intimate partner violence[3] (n=513)	18 (3.5)	7.5 [8.0]	<0.001[b]
Physical violence			
No	506 (98.6)	11.0 [2.0]	0.002[b]
Yes	7 (1.4)	7.0 [8.0]	
Sexual violence (n=513)	0 (0.0)	-	-
Emotional violence			
No	496 (96.7)	11.0 [2.0]	<0.001[b]
Yes	17 (3.3)	7.0 [7.0]	

[1]At least one of the woman's parents was not born in Belgium; [2]low: none or primary education, medium: secondary or post-secondary education, high:, college or university education. [3]At least one type of violence (physical/emotional/sexual) versus no type of violence ; *Data are presented as median [interquartile range]; [a]Spearman rank correlation coefficient; [b]Mann-Whitney U tests; [c]Kruskal-Wallis tests. LMUP: London Measure of Unplanned Pregnancy.

Prevalence of unplanned pregnancy

Scores on the LMUP ranged from 0 to 12 with a median of 11 (inter-quartile range (IQR): 2). Most pregnancies (83.3%, n=430) were categorized as planned, 15.0% (n=77) as ambivalent, and 1.7% (n= 9) as unplanned (Figure 1).

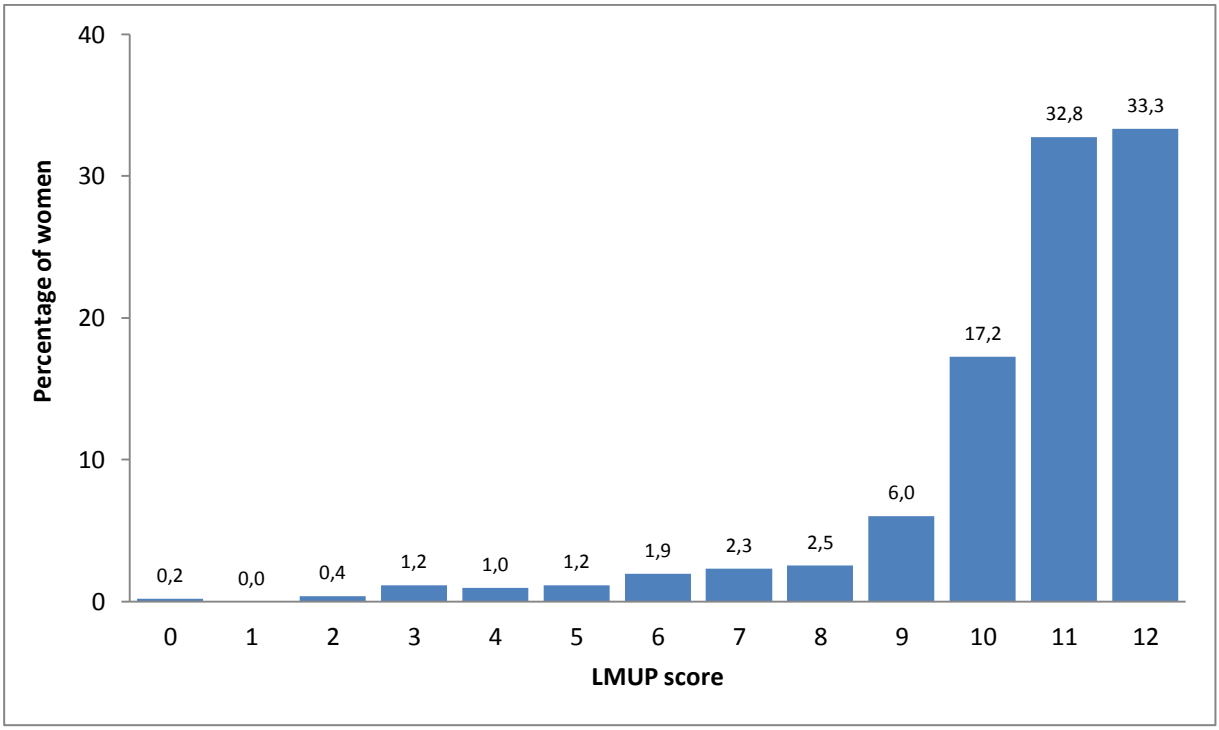

Figure 1. Distribution of total London Measure of Unplanned Pregnancy (LMUP) score

Figure Legend: Distribution of total LMUP score for 517 women on a 0–12 scale; higher scores reflects greater planning for pregnancy.

Ninety-five percent of women (n=486) described their current pregnancy as "wanted", and 5.1% (n=26) as "first unwanted, then wanted". Only one woman (0.2%) defined her pregnancy as "unwanted" (Table 2).

Table 2. Health of women and antenatal characteristics and outcomes

Outcome	Mean (SD)	Range	*p*-value	*rho*-value
BMI[1] (kg/m², n=490)	24.4 (4.6)	15.4 – 45.8	0.65[a]	-0.02
Pregnancy weight gain (kg, n=474)	13.2 (5.4)	-4.0 – 47.0	0.10[a]	0.08
Number of prenatal visits (n=42)	8.9 (2.2)	1.0 – 14.0	0.03[a]	-0.33
First prenatal visit (weeks, n=42)	9.6 (4.3)	5.1 – 30.0	0.26[a]	0.18
Duration of pregnancy (weeks, n=515)	39.3 (1.4)	33.6 – 42.0	0.13[a]	-0.07
Characteristic/outcome	**n (%)**	**LMUP score***	***p*-value**	
Gravida				
First pregnancy	201 (39.0)	11.0 [2.0]	0.02[t]	
Second or subsequent pregnancies	314 (61.0)	11.0 [2.0]		

Characteristic/outcome	n (%)	LMUP score*	*p*-value
Parity			
First birth	247 (48.0)	11.0 [2.0]	<0.001[b]
Second or subsequent births	268 (52.0)	11.0 [2.0]	
Medical History			
Any chronic or serious disease[2]			
No	471 (91.5)	11.0 [2.0]	0.80[b]
Yes	44 (8.5)	11.0 [2.0]	
Drug abuse			
No	495 (96.7)	11.0 [2.0]	0.23[b]
Yes	17 (3.3)	11.0 [6.0]	
Miscarriage			
No	398 (77.3)	11.0 [2.0]	0.26[b]
Yes	117 (22.7)	11.0 [2.0]	
Induced abortion			
No	498 (96.7)	11.0 [2.0]	0.31[b]
Yes	17 (3.3)	11.0 [3.0]	
Complications previous pregnancy			
No	291 (56.5)	11.0 [2.0]	0.40[b]
Yes	224 (43.5)	11.0 [2.0]	
Maternal health before/during pregnancy			
Preconception use of folic acid or vitamins			
No	77 (34.2)	10.0 [2.0]	<0.001[b]
Yes	340 (65.8)	11.0 [1.0]	
Smoking			
No	483 (94.0)	11.0 [2.0]	<0.001[b]
Yes	31 (6.0)	10.0 [3.3]	
Second-hand smoke exposure			
No	429 (83.6)	11.0 [2.0]	0.07[b]
Yes	84 (16.4)	11.0 [2.0]	
Alcohol use			
No	395 (77.8)	11.0 [2.0]	0.87[b]
Yes	113 (22.2)	11.0 [2.0]	
Drug abuse = yes (n=512)	0 (0.0)	-	-
Medication use			
No	318 (61.7)	11.0 [2.0]	0.95[b]
Yes	197 (38.3)	11.0 [2.0]	
Feelings about current pregnancy			
Unwanted	1 (0.2)	-	<0.001[c]
First unwanted, then wanted	26 (5.1)	4.5 [3.0]	
Wanted	486 (94.7)	11.0 [2.0]	
First wanted, then unwanted	0 (0.0)	-	
Complications current pregnancy[3] (n=515)	298 (57.9)	11.0 [2.0]	0.35[b]
Hyperemesis gravidarum			
No	499 (96.9)	11.0 [2.0]	<0.001[b]
Yes	16 (3.1)	10.0 [3.8]	
Gestational diabetes			0.69[b]
No	496 (96.3)	11.0 [2.0]	
Yes	19 (3.7)	11.0 [3.0]	

Bladder- or urinary infection			0.04[b]
No	17 (3.3)	11.0 [2.0]	
Yes	498 (96.7)	11.0 [1.5]	
Hypertension			0.90[b]
No	484 (94.0)	11.0 [2.0]	
Yes	31 (6.0)	11.0 [2.0]	
Intrauterine growth restriction			0.93[b]
No	504 (97.9)	11.0 [2.0]	
Yes	11 (2.1)	11.0 [3.0]	
Placenta previa			0.53[b]
No	512 (99.4)	11.0 [2.0]	
Yes	3 (0.6)	12.0 [-]	
Abruptio placentae	0 (0.0)	-	
HELLP[4] syndrome			0.23[b]
No	514 (99.8)	11.0 [2.0]	
Yes	1 (0.2)	-	
Pre-eclampsia			0.17[b]
No	507 (98.4)	11.0 [2.0]	
Yes	8 (1.6)	12.0 [1.8]	
Premature rupture of membranes			0.60[b]
No	506 (98.3)	11.0 [2.0]	
Yes	9 (1.7)	11.0 [3.0]	
Preterm premature rupture of membranes			0.22[b]
No	510 (99.0)	11.0 [2.0]	
Yes	5 (1.0)	12.0 [2.0]	
Preterm contractions			0.13[b]
No	477 (92.6)	11.0 [2.0]	
Yes	38 (7.4)	11.0 [2.3]	
Anaemia			0.62[b]
No	475 (92.2)	11.0 [2.0]	
Yes	40 (7.8)	11.0 [2.0]	
Calcium deficiency	0 (0.0)	-	
Iodine deficiency	0 (0.0)	-	
CMV infection			0.53[b]
No	509 (98.8)	11.0 [2.0]	
Yes	6 (1.2)	11.0 [1.3]	
Toxoplasmosis infection	0 (0.0)	-	
Other infection disease			0.91[b]
No	428 (83.1)	11.0 [2.0]	
Yes	87 (16.9)	11.0 [2.0]	
Environmental exposure	0 (0.0)	-	
Other pregnancy symptoms/problems			
No	357 (69.3)	11.0 [2.0]	0.46[b]
Yes	158 (30.7)	11.0 [2.0]	

[1]Pre-pregnancy BMI; [2]asthma, diabetes mellitus, cancer, congenital, endocrine, hypertension, infectious / STI, psychiatric, epilepsy or other diseases; [3]At least one complication or intervention versus no complication or intervention; [4]Hemolysis, elevated liver enzymes, and low platelets; *Data are presented as median [interquartile range]. CMV : cytomegalovirus, HELLP: hemolysis, elevated liver enzyme levels, and low platelet levels. [a]Spearman rank correlation coefficient; [b]Mann-Whitney U tests; [c]Kruskal-Wallis tests.

Associated socio-demographic factors

Results showed that women who are multigravida (95% CI -0.30 – -0.02), less well educated (95% CI 0.07 – 0.85), single or having a non-cohabiting relationship (95% CI 0.01 – 2.53), having a history of drug abuse (95% CI -2.07 – -0.35), and experiencing intimate partner violence (95% CI -3.82 – -1.59) tended to have significantly lower LMUP scores, and hence a higher risk of a more unplanned pregnancy (Table 3).

Table 3. Final model predicting LMUP: multiple linear regression analysis

Characteristic	B	Standard error	Beta	*t*-value	*p*-value	95% CI*
Ethnicity[1]	0.25	0.28	0.04	0.91	0.36	-0.29 – 0.80
Education[2]	0.46	0.20	0.11	2.31	0.02	0.07 – 0.85
Paid employment[3]	0.53	0.31	0.08	1.70	0.09	-0.08 – 1.14
Net household income[4]	-0.51	0.31	-0.09	-1.64	0.10	-1.11 – 0.10
Household subjectivepoverty[5]	0.33	0.25	0.06	1.33	0.19	-0.16 – 0.81
Marital status[6]	1.27	0.64	0.09	1.98	0.05	0.01 – 2.53
Education of partner[2]	0.24	0.19	0.06	1.24	0.22	-0.14 – 0.62
Paid employment partner[3]	0.36	0.54	0.03	0.68	0.50	-0.70 – 1.42
Intimate partner violence[7]	-2.71	0.57	-0.22	-4.78	<0.001	-3.82 – -1.59
History of drug abuse[8]	-1.21	0.44	-0.12	-2.78	0.006	-2.07 – -0.35
Gravida	-0.16	0.07	-0.10	-2.20	0.03	-0.30 – -0.02
Constant	7.03	1.26		5.57	<0.001	4.55 – 9.51

[1]Immigrants is the reference category compared to natives; [2]Low and medium education is reference category compared to high education; [3]No paid employment is reference category; [4]< 2.500 euro is reference category; [5]Difficult to make ends meet is reference category; [6]Non-cohabiting relationship and being single is reference category compared to cohabiting relationship ; [7]No intimate partner violence is reference category; [8]No history of drug abuse is reference category; *95% CI; R^2: 0.17, adjusted R^2: 0.14, F= 7.94, p < 0.001.

Associated pregnancy outcomes

Lower LMUP scores were significantly associated with initially unwanted pregnancies (p<0.001), no folic acid or vitamin use before pregnancy (p<0.001), lower number of prenatal visits (p=0.03), smoking during pregnancy (p<0.001), more stress (p=0.002), lower relationship satisfaction (p=0.001), and less social support (p<0.001).

Lower LMUP scores were significantly associated with hyperemesis gravidarum (p<0.001) and shorter duration of delivery (p=0.03). Although the LMUP score was significantly associated with bladder or urinary infection (p=0.04), other interventions or complications during delivery (p=0.02), and no episiotomy at delivery (p=0.002), the median did not differ between the groups (Tables 2 and 4). No differences were found in neonatal health outcomes (Table 5).

Table 4. Intrapartum and postpartum outcomes

Outcome	Mean (SD)	Range	*p*-value	*rho*-value
Duration of labor (hours, n=425)	7.5 (5.5)	0.2 – 29.2	0.25[a]	0.06
Duration of delivery (hours, n= 409)	0.5 (0.3)	0.0 – 2.1	0.03[a]	0.11

Outcome	n (%)	LMUP score*	*p*-value
Onset of labor			
Spontaneous	333 (64.7)	11.0 [2.0]	0.94[c]
Induction	114 (22.1)	11.0 [2.0]	
Planned caesarean section	68 (13.2)	11.0 [2.0]	
Epidural anaesthesia			
No	161 (31.3)	11.0 [2.0]	0.24[b]
Yes	354 (68.7)	11.0 [2.0]	
Amniotic fluid color			
Clear	410 (85.6)	11.0 [2.0]	0.98[c]
Meconium stained	54 (11.3)	11.0 [2.0]	
Bloody	15 (3.1)	11.0 [3.0]	
Interventions and complications during delivery[1] (n=515)	387 (75.1)	11.0 [2.0]	0.08[b]
Instrumental vaginal delivery			
No	465 (90.3)	11.0 [2.0]	0.23[b]
Yes	50 (9.7)	11.0 [2.0]	
Episiotomy			
No	301 (58.4)	11.0 [2.0]	0.002[b]
Yes	214 (41.6)	11.0 [2.0]	
Perineal laceration			
No	398 (77.3)	11.0 [2.0]	0.29[b]
Yes	117 (22.7)	11.0 [2.0]	
Shoulder dystocia			
No	508 (98.6)	11.0 [2.0]	0.05[b]
Yes	7 (1.4)	12.0 [1.0]	
Emergency caesarean section			
No	477 (92.6)	11.0 [2.0]	0.92[b]
Yes	38 (7.4)	11.0 [2.0]	
Primary postpartum hemorrhage[2]			
No	495 (96.1)	11.0 [2.0]	0.60[b]
Yes	20 (3.9)	11.0 [2.0]	
Sepsis	0 (0.0)	-	
Mors in utero	0 (0.0)	-	
Other intervention/complication			0.02[b]
No	426 (82.7)	11.0 [2.0]	
Yes	89 (17.3)	11.0 [3.0]	
Breastfeeding			
No	132 (25.6)	11.0 [2.0]	0.07[b]
Yes	383 (74.4)	11.0 [2.0]	
Postpartum complications[1]	46 (8.9)	11.0 [3.0]	0.35[b]
Secondary postpartum haemorrhage[3]			
No	510 (99.0)	11.0 [2.0]	0.80[b]
Yes	5 (1.0)	11.0 [1.5]	
Infection			
No	512 (99.4)	11.0 [2.0]	0.53[b]
Yes	3 (0.6)	12.0 [-]	
Sepsis	0 (0.0)	-	-
Postpartum depression	0 (0.0)	-	-
Psychosis	0 (0.0)	-	-
Other postpartum complications			
No	474 (92.0)	11.0 [2.0]	0.38[b]
Yes	41 (8.0)	11.0 [3.0]	

[1]At least one complication or intervention versus no complication or intervention; [2]Blood loss of 500 ml or more during the first 24 hours after delivery; [3]Abnormal or excessive blood loss between 24 hours and 12 weeks postpartum; *Data are presented as median [interquartile range]; [a]Spearman rank correlation coefficient; [b]Mann-Whitney U tests; [c]Kruskal-Wallis tests.

Table 5. Neonatal outcomes

Outcome	Mean (SD)	Range	*p*-value	*rho*-value
Birth length (centimeters, n=509)	49.7 (2.1)	41.0 – 56.0	0.85[a]	-0.009
Birth weight (grams, n=515)	3366.3 (485.2)	1490.0 – 4700.0	0.37[a]	-0.04
Outcome	**n (%)**	**LMUP score***	***p*-value**	
Twin pregnancy				
No	504 (97.9)	11.0 [2.0]	0.52[b]	
Yes	11 (2.1)	11.0 [2.0]		
Complications or interventions[1] (n=515)	327 (63.5)	11.0 [2.0]	0.35[b]	
Low birthweight (<2500 g)				
No	493 (95.7)	11.0 [2.0]	0.17[b]	
Yes	22 (4.3)	11.0 [1.0]		
Macrosomia (>4000 g)				
No	475 (92.2)	11.0 [2.0]	0.59[b]	
Yes	40 (7.8)	11.0 [2.0]		
Neonatal unit admission				
No	475 (92.2)	11.0 [2.0]	0.52[b]	
Yes	40 (7.8)	11.0 [2.0]		
Congenital malformations				
No	514 (99.8)	11.0 [2.0]	0.23[b]	
Yes	1 (0.2)	-		
Brachial plexus injury	0 (0.0)	-	-	
Hyperbilirubinemia				
No	490 (95.1)	11.0 [2.0]	0.69[b]	
Yes	25 (4.9)	11.0 [2.0]		
Neonatal death	0 (0.0)	-		
Other complications/interventions				
No	390 (75.7)	11.0 [2.0]	0.63[b]	
Yes	125 (24.3)	11.0 [2.0]		

[1]At least one complication or intervention; *Data are presented as median [interquartile range]; [a]Spearman rank correlation coefficient; [b]Mann-Whitney U tests; [c]Kruskal-Wallis tests.

DISCUSSION

Our study aimed to assess the prevalence, associated factors, and maternal and neonatal health outcomes of unplanned pregnancies ending in birth.

The current study found that 83% of the pregnancies were planned, 15% were ambivalent and only 2% of the pregnancies were unplanned. Although our results differ from previous studies, which reported a higher prevalence of unplanned pregnancies, they are consistent with European studies also using the LMUP, which reported a prevalence rate of 2% to 9% for unplanned pregnancies leading to birth (Lakha and Glasier, 2006; Wellings et al., 2013; Backhausen et al., 2014; Stephenson et al., 2014; Bexhell et al., 2016). These findings confirm that differences in definition and measurements can lead to inconsistent prevalence rates, and

support the need for a clear definition and an appropriate measurement tool that takes into account the complexities of the construct (Petersen and Moos, 1997; Klerman, 2000; Rowe et al., 2015).

Another important finding was that socially disadvantaged women (lower education, single or non-cohabiting relationship, experiencing IPV) tended to have a higher risk of less planned pregnancies, and these pregnancies were more likely to be high-risk pregnancies (no preconception use of folic acid or vitamins, less antenatal care visits, smoking during pregnancy, more stress, lower relationship satisfaction, and less social support). These results are in line with those of previous studies (Mallard and Houghton 2013; Maxson and Miranda 2011; Nelson and Lepore 2013). It is possible that socially disadvantaged women fail to use contraception correctly and consistently due to knowledge, access, cultural, personal, and relationship factors (Pratt et al., 2014). Ambivalence towards avoiding pregnancy is also more common among women of lower SES (Aiken et al., 2015; Borrero et al., 2015). Women who live in a fragile socio-economic environment often see motherhood as an escape from hardship to a better life and an attainable goal that will provide personal satisfaction and achievement (Fedorowicz et al., 2014; Pratt et al., 2014).

Previous research suggests that unintended and unplanned pregnancies are associated with an increased risk of adverse antenatal and birth outcomes (Mohllajee et al., 2007; Gipson et al., 2008; Shah et al., 2011). Our findings suggest no major differences in pregnancy outcome according to pregnancy planning, as found in earlier studies (Postlethwaite et al., 2010; McCrory and McNally, 2013). This discrepancy could be attributed to differences in definition and methodology. It is possible that unwanted pregnancies have a higher risk for poor pregnancy outcomes rather than mistimed or unplanned pregnancies (D'Angelo et al., 2004). One interesting finding is that lower LMUP scores were associated with shorter duration of delivery. Lower LMUP scores were also associated with higher parity, and therefore, could explain the shorter delivery time as women with subsequent births tend to deliver more quickly. Another interesting finding is the fact that hyperemesis was more prevalent among women with a more unplanned pregnancy. To date, only few studies investigated the association between pregnancy planning and hyperemesis (Aksoy, 2008; Chou et al., 2008). Our results may support the hypothesis that severe nausea and vomiting of pregnancy can be a reaction to stress and poor social support (Buckwalter and Simpson, 2002), which is associated with a pregnancy that is more unplanned. Chou et al. (2008) suggested the opposite cause-effect relationship, namely that pregnancy-related nausea and vomiting, poor social support and unplanned pregnancy are factors that contribute to stress, which has a negative impact on maternal psychosocial adaptation. Further research is required to investigate the relationship between pregnancy planning and hyperemesis gravidarum.

As in any other study, this research has some limitations that must be considered in interpreting the results. First, the pre-test included only six native women of whom five were medium or higher educated. As a result, it

is possible that some words, items of expression are less readable or too difficult to read and understand to women of lower socio-economic status. Second, there is a risk of sampling bias; although midwives were instructed to invite all eligible women to participate, it is possible that women with adverse birth outcomes were not informed about the study or refused to participate. The proportion of women included in the study was based on total deliveries during the study time and nationality data, as no other information was available. The actual proportion might differ from our estimated 22% because nationality is only an indicator of language. Third, although we could have reached most women giving birth recently in Flanders (99.3% deliver at hospital, Devlieger, 2014), only women with an understanding of the written Dutch language were eligible to participate, leading to selection bias. Our sample characteristics (education, employment, income, marital status, nationality) confirm an overrepresentation of women with higher SES. Therefore, the prevalence of unplanned pregnancies is, in all probability, underestimated as unplanned pregnancies are associated with lower SES as concluded by other studies. Fourth, women were recruited during the first 5 days postpartum, which is an emotional time. Therefore, both negative (exhaustion, "baby blues", stress…) and positive (happiness, pride, joy, protectiveness…) feelings may have influenced the answer to certain questions, such as perceived stress, relationship satisfaction, and social support. Fifth, because of the cross-sectional design of the study, causality between pregnancy planning and antenatal and perinatal outcomes cannot be inferred.
Strengths of this study include the use of a validated and reliable instrument to measure such a complex construct as pregnancy planning. Yet one item of the LMUP addresses preconception health behavior, of which knowledge is an important precondition. It is possible that women did not improve their lifestyle prior to pregnancy due to lack of knowledge, and therefore have a lower score on the LMUP. Another strength is that this is one of the first studies that analyzed pregnancy planning as a continuous variable, and takes into account the complexity of the construct. A further strength is the combination of self-reported data and data extracted from medical records. In addition, several aspects of unplanned pregnancy were investigated (prevalence, associated factors, and health outcome) in the same study resulting in comprehensive data.

Further research on women of lower SES is needed as these subgroups are at risk for unplanned pregnancy. Our data suggest that socially disadvantaged women should remain the main target group for prevention of unplanned pregnancies. These women are often "hard to reach" through traditional healthcare services, therefore, school- and community based interventions may be more appropriate to help reduce unplanned pregnancies.

In this study, information about pregnancy planning was lacking in most medical records suggesting it was not discussed or registered. Meiksin et al. (2010) found that discussions between patients and providers about

pregnancy planning and related psychosocial feelings tend to be brief, and often framed as closed-ended questions. An open-ended question during the first prenatal visit could be an opportunity for patients to discuss their pregnancy intention and related feelings. Moreover, a safe and open atmosphere could lead to a conversation about other sensitive topics such as IPV.

In summary, we found that four in five pregnancies were planned i.e. only one in five pregnancies was unplanned or ambivalent. Less planned pregnancies tended to be more prevalent among socially disadvantaged women. Although no major differences were found in pregnancy outcome according to pregnancy planning, pregnancies that are more unplanned deserve attention as they were more likely to be high-risk pregnancies.

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CONFLICT OF INTEREST

None declared.

REFERENCE LIST

Abajobir AA, Maravilla JC, Alati R, Najman JM (2016) A systematic review and meta-analysis of the association between unintended pregnancy and perinatal depression. Journal of affective disorders 192:56-63.

Aiken AR, Dillaway C, Mevs-Korff N (2015) A blessing I can't afford: factors underlying the paradox of happiness about unintended pregnancy. Social science & medicine (1982) 132:149-155.

Aksoy AN (2008) Hyperemesis Incidence in Planned versus Unplanned Pregnancy. The Eurasian journal of medicine 40:72-74.

Backhausen MG, Ekstrand M, Tyden T, Magnussen BK, Shawe J, Stern J, Hegaard HK (2014) Pregnancy planning and lifestyle prior to conception and during early pregnancy among Danish women. Eur J Contracept Reprod Health Care 19:57-65.

Barrett G, Wellings K (2002) What is a 'planned' pregnancy? Empirical data from a British study. Social science & medicine (1982) 55:545-557.

Barrett G, Smith SC, Wellings K (2004) Conceptualisation, development, and evaluation of a measure of unplanned pregnancy. J Epidemiol Community Health 58:426-433.

Bexhell H, Guthrie K, Cleland K, Trussell J (2016) Unplanned pregnancy and contraceptive use in Hull and East Yorkshire. Contraception 93:233-235.

Borrero S, Nikolajski C, Steinberg JR, Freedman L, Akers AY, Ibrahim S, Schwarz EB (2015) "It just happens": a qualitative study exploring low-income women's perspectives on pregnancy intention and planning. Contraception 91:150-156.

Buckwalter JG, Simpson SW (2002) Psychological factors in the etiology and treatment of severe nausea and vomiting in pregnancy. American journal of obstetrics and gynecology 186:S210-214.

Chan Y (2004) Biostatistics 201: linear regression analysis. Age (years) 80:140.

Chou FH, Avant KC, Kuo SH, Fetzer SJ (2008) Relationships between nausea and vomiting, perceived stress, social support, pregnancy planning, and psychosocial adaptation in a sample of mothers: a questionnaire survey. International journal of nursing studies 45:1185-1191.

Cohen S, Kamarck T, Mermelstein R (1983) A global measure of perceived stress. Journal of health and social behavior 24:385-396.

D'Angelo DV, Gilbert BC, Rochat RW, Santelli JS, Herold JM (2004) Differences between mistimed and unwanted pregnancies among women who have live births. Perspect Sex Reprod Health 36:192-197.

Devlieger RM, E.; Martens, G.; Van Mol, C.; Cammu, H. (2014) Perinatale activiteiten in Vlaanderen. 2006 (Perinatal activities in Flanders) Brussels: SPE.

Fedorowicz AR, Hellerstedt WL, Schreiner PJ, Bolland JM (2014) Associations of adolescent hopelessness and self-worth with pregnancy attempts and pregnancy desire. Am J Public Health 104:e133-140.

Frost JJ, Singh S, Finer LB (2007) Factors associated with contraceptive use and nonuse, United States, 2004. Perspect Sex Reprod Health 39:90-99.

Galle A, Van Parys AS, Roelens K, Keygnaert I (2015) Expectations and satisfaction with antenatal care among pregnant women with a focus on vulnerable groups: a descriptive study in Ghent. BMC women's health 15:112.

Gipson JD, Koenig MA, Hindin MJ (2008) The effects of unintended pregnancy on infant, child, and parental health: a review of the literature. Studies in family planning 39:18-38.

Hall JA, Barrett G, Copas A, Stephenson J (2017) London Measure of Unplanned Pregnancy: guidance for its use as an outcome measure. Patient related outcome measures 8:43.

Higgins JA, Popkin RA, Santelli JS (2012) Pregnancy ambivalence and contraceptive use among young adults in the United States. Perspectives on sexual and reproductive health 44:236-243.

IBM Corporation (2012) IBM SPSS Statistics for Windows, Version 21.0. In. Armonk, NY: IBM Corp.

Klerman LV (2000) The Intendedness of Pregnancy: A Concept in Transition. Maternal and Child Health Journal 4:155-162.

Lakha F, Glasier A (2006) Unintended pregnancy and use of emergency contraception among a large cohort of women attending for antenatal care or abortion in Scotland. Lancet (London, England) 368:1782-1787.

Lee EH (2012) Review of the psychometric evidence of the perceived stress scale. Asian nursing research 6:121-127.

Lukasse M, Laanpere M, Karro H, Kristjansdottir H, Schroll AM, Van Parys AS, Wangel AM, Schei B (2015) Pregnancy intendedness and the association with physical, sexual and emotional abuse - a European multi-country cross-sectional study. BMC pregnancy and childbirth 15:120.

Mallard SR, Houghton LA (2013) Socio-demographic characteristics associated with unplanned pregnancy in New Zealand: implications for access to preconception healthcare. The Australian & New Zealand journal of obstetrics & gynaecology 53:498-501.

Maxson P, Miranda ML (2011) Pregnancy intention, demographic differences, and psychosocial health. Journal of women's health (2002) 20:1215-1223.

McCrory C, McNally S (2013) The effect of pregnancy intention on maternal prenatal behaviours and parent and child health: results of an irish cohort study. Paediatric and perinatal epidemiology 27:208-215.

Meiksin R, Chang JC, Bhargava T, Arnold R, Dado D, Frankel R, Rodriguez KL, Ling B, Zickmund S (2010) Now is the chance: patient-provider communication about unplanned pregnancy during the first prenatal visit. Patient education and counseling 81:462-467.

Mohllajee AP, Curtis KM, Morrow B, Marchbanks PA (2007) Pregnancy intention and its relationship to birth and maternal outcomes. Obstetrics and gynecology 109:678-686.

Nelson DB, Lepore SJ (2013) The role of stress, depression, and violence on unintended pregnancy among young urban women. Journal of women's health (2002) 22:673-680.

Petersen R, Moos MK (1997) Defining and measuring unintended pregnancy: issues and concerns. Women's health issues : official publication of the Jacobs Institute of Women's Health 7:234-240.

Polit DF, Beck CT (2010) Essentials of Nursing Research: Appraising Evidence for Nursing Practice: Wolters Kluwer Health / Lippincott Williams & Wilkins.

Postlethwaite D, Armstrong MA, Hung YY, Shaber R (2010) Pregnancy outcomes by pregnancy intention in a managed care setting. Matern Child Health J 14:227-234.

Pratt R, Stephenson J, Mann S (2014) What influences contraceptive behaviour in women who experience unintended pregnancy? A systematic review of qualitative research. J Obstet Gynaecol 34:693-699.

Rocca CH, Krishnan S, Barrett G, Wilson M (2010) Measuring pregnancy planning: An assessment of the London Measure of Unplanned Pregnancy among urban, south Indian women. Demographic research 23:293-334.

Rowe H, Holton S, Kirkman M, Bayly C, Jordan L, McNamee K, McBain J, Sinnott V, Fisher J (2015) Prevalence and distribution of unintended pregnancy: the Understanding Fertility Management in Australia National Survey. Australian and New Zealand journal of public health.

Santelli J, Rochat R, Hatfield-Timajchy K, Gilbert BC, Curtis K, Cabral R, Hirsch JS, Schieve L (2003) The measurement and meaning of unintended pregnancy. Perspectives on sexual and reproductive health 35:94-101.

SAS institute Inc. (2010) SAS Power & Sample Size, version 3.1 In. Cary, NC, USA.

Schwarz EB, Lohr PA, Gold MA, Gerbert B (2007) Prevalence and correlates of ambivalence towards pregnancy among nonpregnant women. Contraception 75:305-310.

Sedgh G, Singh S, Hussain R (2014) Intended and unintended pregnancies worldwide in 2012 and recent trends. Stud Fam Plann 45:301-314.

Shah PS, Balkhair T, Ohlsson A, Beyene J, Scott F, Frick C (2011) Intention to become pregnant and low birth weight and preterm birth: a systematic review. Matern Child Health J 15:205-216.

Stanford JB, Hobbs R, Jameson P, DeWitt MJ, Fischer RC (2000) Defining dimensions of pregnancy intendedness. Matern Child Health J 4:183-189.

Stephenson J, Patel D, Barrett G, Howden B, Copas A, Ojukwu O, Pandya P, Shawe J (2014) How do women prepare for pregnancy? Preconception experiences of women attending antenatal services and views of health professionals. PLoS One 9:e103085.

Stern J, Joelsson LS, Tyden T, Berglund A, Ekstrand M, Hegaard H, Aarts C, Rosenblad A, Larsson M, Kristiansson P (2016) Is pregnancy planning associated with background characteristics and pregnancy-planning behavior? Acta Obstet Gynecol Scand 95:182-189.

Takahashi S, Tsuchiya KJ, Matsumoto K, Suzuki K, Mori N, Takei N (2012) Psychosocial determinants of mistimed and unwanted pregnancy: the Hamamatsu Birth Cohort (HBC) study. Matern Child Health J 16:947-955.

United Nations (2015) The Millennium Development Goals Report 2015. In.

U.S. Department of Health and Human Services (2010) Healthy People 2020: National Health Promotion and Disease Prevention Objectives. Maternal, Infant, and Child Health : Preconception Health and Behaviors. In: Healthy People 2020.

Wellings K, Jones KG, Mercer CH, Tanton C, Clifton S, Datta J, Copas AJ, Erens B, Gibson LJ, Macdowall W, Sonnenberg P, Phelps A, Johnson AM (2013) The prevalence of unplanned pregnancy and associated factors in Britain: findings

from the third National Survey of Sexual Attitudes and Lifestyles (Natsal-3). Lancet (London, England) 382:1807-1816.

World Health Organization (2009) Management of substance abuse: Process of translation and adaptation of instruments. In WHO.

Yanikkerem E, Ay S, Piro N (2013) Planned and unplanned pregnancy: effects on health practice and depression during pregnancy. The journal of obstetrics and gynaecology research 39:180-187.

Zimet GD, Dahlem NW, Zimet SG, Farley GK (1988) The multidimensional scale of perceived social support. Journal of personality assessment 52:30-41.

CHAPTER 5

PRECONCEPTION LIFESTYLE CHANGES IN WOMEN WITH PLANNED PREGNANCIES

Based on the article of Goossens, J., Beeckman, D., Van Hecke, A., Delbaere, I., Verhaeghe, S. (2018). Preconception lifestyle changes in women with planned pregnancies. Midwifery 56, 112-120. doi: 10.1016/j.midw.2017.10.004. Category NURSING: 13/114 (Q1) – IF: 1.948.

ABSTRACT

Objectives: (1) to study preconception lifestyle changes and associated factors in women with planned pregnancies; (2) to assess the prevalence of risk factors for adverse pregnancy outcomes in women not reporting any preconception lifestyle changes; and (3) to explore the need for and use of preconception-related advice.

Design: secondary data analysis of a cross-sectional study about pregnancy planning.

Setting: six Flemish Hospitals (Belgium).

Participants: four hundred and thirty women with a planned pregnancy ending in birth.

Measurements: preconception lifestyle changes were measured during the first 5 days postpartum using the validated London Measure of Unplanned Pregnancy. The following changes were assessed: folic acid or multivitamin intake, smoking reduction or cessation, alcohol reduction or cessation, caffeine reduction or cessation, eating more healthily, achieving a healthier weight, obtaining medical or health advice, or another self-reported preconception lifestyle change.

Findings: most women (83%) that planned their pregnancy reported ≥1 lifestyle change in preparation for pregnancy. Overall, nulliparous women (OR 2.18, 95% CI 1.23–3.87) and women with a previous miscarriage (OR 2.44, 95% CI 1.14–5.21) were more likely to prepare for pregnancy, while experiencing financial difficulties (OR 0.20, 95% CI 0.04–0.97) or having a lower educational level (OR 0.56, 95% CI 0.32–0.99) decreased the likelihood of preparing for pregnancy. Half of the women (48%) obtained advice about preconception health, and 86% of these women received their advice from a professional caregiver. Three-quarters (77%) of the women who did not improve their lifestyle before conceiving reported one or more risk factors for adverse pregnancy outcomes.

Key Conclusions and implications for practice: Multiparous women and women of lower socio-economic status were less likely to change their lifestyle before conception. Strategies to promote preconception health in these women need to be tailored to their needs and characteristics to overcome barriers to change. It may be advantageous to reach these women through non-medical channels, such as schools or other community organizations.

Keywords: Preconception care, preconception health, preconception lifestyle, reproductive behavior, reproductive health

INTRODUCTION

Previous research has reported that unplanned and unintended pregnancies are associated with an increased risk of adverse antenatal and birth outcomes, including preterm birth, low birth weight, increased risk of

congenital anomalies, and developmental delay (Mohllajee et al., 2007; Gipson et al., 2008; Shah et al., 2011). This finding suggests that pregnancy planning has an influence on maternal and neonatal health. Women who are consciously planning a pregnancy can improve their health status during the preconception period. A healthy lifestyle and lifestyle changes prior to conception— including a healthy diet; adequate physical activity and optimal weight; folic acid supplementation; avoidance of tobacco, alcohol and other teratogen exposures; and prevention, treatment and management of (infectious) diseases and medical conditions—can lead to a healthier pregnancy and a decreased risk of childhood morbidity and mortality (Johnson et al., 2006; Jack et al., 2008; World Health Organization, 2013). Several European and US studies have shown that women who planned their pregnancy were more likely to adopt healthier preconception behaviors, including intake of folic acid, smoking cessation, and reduced alcohol consumption (Green-Raleigh et al., 2005; Tyden et al., 2011; Backhausen et al., 2014; Stephenson et al., 2014; Stern et al., 2016). For example, a Danish cross-sectional study with 258 pregnant women found that women with a well-planned pregnancy were more likely to take folic acid (57% versus 2%) and to report less binge drinking (20% versus 31%) prior to pregnancy compared to women with an unplanned pregnancy (Backhausen et al., 2014). Although most of these studies found significant differences in preconception health behavior between planned and unplanned pregnancies, the differences are often marginal. This implies that many women who are consciously planning a pregnancy do not change their lifestyle before conception (Inskip et al., 2009; Chuang et al., 2011; Backhausen et al., 2014; Stephenson et al., 2014; Stern et al., 2016).

Previously published studies on lifestyle changes during the preconception period and its associated factors in women trying to conceive or having a planned pregnancy are inconsistent (Anderson et al., 2006; Lipscombe et al., 2011; De Santis et al., 2013; Mirghafourvand et al., 2014; Gormack et al., 2015; Joelsson et al., 2016). Several studies found that women who reported preconception lifestyle changes were more likely to be married, older, and nulliparous and to have a higher level of education, health insurance, and sufficient family income (Anderson et al., 2006; Lipscombe et al., 2011; De Santis et al., 2013; Mirghafourvand et al., 2014; Joelsson et al., 2016). However, other studies found no or contrasting associations between demographics and preconception lifestyle changes (Lum et al., 2011; Gormack et al., 2015; Borges et al., 2016). Moreover, the majority of these studies focused on only one or a few preconception lifestyle changes, such as folic acid intake and/or reduction or cessation of alcohol use and smoking before pregnancy (Anderson et al., 2006; Lum et al., 2011; De Santis et al., 2013; Joelsson et al., 2016), or were conducted in women who had a medical condition, such as infertility or diabetes mellitus (Lipscombe et al., 2011; Mirghafourvand et al., 2014; Gormack et al., 2015; Joelsson et al., 2016). To date, there are few studies that have investigated a broad range of preconception lifestyle changes in the general population of women who are trying to conceive or who planned their pregnancy.

To develop effective strategies to promote healthy preconception lifestyle in women who are planning to become pregnant, it is necessary to gain insight into which women adopt a healthier lifestyle before conceiving (Bartholomew et al., 2011; World Health Organization, 2013). To date, very little is known about the lifestyle behaviors of women who are planning to become pregnant but do not report any preconception lifestyle changes. It remains unclear whether these women already have a healthy lifestyle in the preconception period and, therefore, do not need to adopt a healthier preconception lifestyle. Recent evidence suggests that offering preconception health information through the Internet and a healthcare provider may be an important strategy to improve the uptake of preconception care because information-seeking behavior seems to be associated with positive changes in lifestyle during the preconception period (Poels et al., 2017). Previous published research suggests that women prefer to receive preconception information from a healthcare provider (Frey and Files, 2006; Goossens et al., 2016b; van Voorst et al., 2017), while other studies found that the majority of women searched for preconception information elsewhere (Stephenson et al., 2014; Poels et al., 2017). In addition, previous research on preconception health information included all women, irrespective of their pregnancy intention (Frey and Files, 2006; Stephenson et al., 2014; Goossens et al., 2016b; Poels et al., 2017; van Voorst et al., 2017). Therefore, it would be interesting to gain insight into ways in which women who have planned their pregnancy acquired information regarding preconception health.

The aim of this study was to investigate preconception lifestyle changes in women with a planned pregnancy and assess the socio-demographic, health, and lifestyle characteristics associated with pregnancy planning. We also assessed the prevalence of medical and lifestyle risk factors for adverse pregnancy outcomes in women not reporting any preconception lifestyle changes. A further objective was to explore the need for and use of preconception-related advice.

METHODS

Study Design and Sample

Data were taken from a cross-sectional study assessing the prevalence, associated factors, and maternal and neonatal health outcomes of planned and unplanned pregnancies. A detailed description of the methodology of this study has been published elsewhere (Goossens et al., 2016a). In summary, women aged 15–45, able to read Dutch, and admitted to the postnatal maternity ward were approached between March and September 2015 in six Flemish Hospitals (Belgium) during the first five days postpartum. In total, 517 women (22% response rate) were included in the study. A combination of data from a self-administered questionnaire and information derived from medical records were collected. The study was approved by the Ghent University

Hospital Ethics Committee (B670201524084 & B670201524085) and the local ethical committees of the participating hospitals. All participants provided written informed consent.

The analytic sample consisted of women with a planned pregnancy according to the London Measure of Unplanned Pregnancy (LMUP; Barrett et al., 2004). The original English version of the LMUP has excellent psychometric properties (Cronbach's α = 0.92, test-retest weighted Kappa = 0.97). The psychometric properties of the Dutch version of the LMUP were evaluated, and these findings provide support for the reliability and validity of the Dutch version of the LMUP (Cronbach's α = 0.74, Loevinger's coefficient = 0.57, Goossens, 2017). The total score on the LMUP ranges from 0 to 12; higher scores correspond to a higher degree of pregnancy planning (scores 0–3: "unplanned"; scores 4–9: "ambivalent"; and scores 10–12: "planned"). Women were excluded if the LMUP score was between 0 and 9 (n = 87), which resulted in an analyzed sample of 430 women with a planned pregnancy.

Measurement

Preconception lifestyle changes

Preconception lifestyle changes were examined by the following item in the LMUP: "Before you became pregnant, did you do anything to improve your health in preparation for pregnancy?" Response options included "took folic acid", "stopped or cut down smoking", "stopped or cut down drinking alcohol", "ate more healthily", "sought medical or health advice", "took some other action" (open question), and "I did not do any of the above before my pregnancy". Three preconception lifestyle changes were added because they are more common among women in Flanders preparing for pregnancy (multi-vitamin use), and because of international recommendations and studies on preconception health (reduction of caffeine and achieving a healthy weight; Jack et al., 2008; Lassi et al., 2014; Temel et al., 2015). All participants were also asked the following question: "Just before you became pregnant, did you seek medical or health advice in preparation for pregnancy?" Participants who answered "yes" were asked which preconception-related information needs they had and which information sources they consulted.

Participant characteristics

Information on lifestyle behavior included smoking, second-hand smoking, and drug and alcohol use. Smoking was measured by asking "Do you smoke?" Participants who answered "yes" were asked how many cigarettes they smoke each day on average. Those who answered "no" were asked if they did smoke in the past and, if so, when they stopped smoking (after discovering the current pregnancy, just before the current pregnancy, other reasons than the current pregnancy). Drug and alcohol use were measured in a similar way. Participants were also asked about their perceived social support using the Multidimensional Scale of Perceived Social Support

(Zimet et al., 1988), and their perceived stress using the 10-item Perceived Stress Scale (Cohen et al., 1983). Demographics included age, nationality, ethnicity, education level, occupation, living situation, net household income, perceived poverty, religion, partnership status, length of the relationship, relationship satisfaction, and occupation and education level of the partner. Comprehensive data on medical and obstetric history, pregnancy, delivery, and birth outcomes were derived from medical records.

Risk factors

The categorization of risk factors that may influence the pregnancy outcome among women reporting no preconception lifestyle changes was based on a study by van der Pal-de Bruin et al. (2008). Both pre-pregnancy smoking (any cigarette use) and pre-pregnancy alcohol use (any alcohol use) were considered as risk factors for adverse pregnancy outcomes. Body mass index (BMI) was calculated from height and pre-pregnancy weight was obtained from medical records and categorized according to the World Health Organization (WHO) classification as follows: < 18.50 kg/m², underweight; 18.50 – 24.99 kg/m², normal weight; 25.00 – 29.99 kg/m², overweight; and ≥ 30.00 kg/m², obese (World Health Organization, 2000). Underweight, overweight, and obesity were considered risk factors for adverse pregnancy outcomes. Chronic or other serious diseases (e.g., asthma and diabetes mellitus), and diseases or disorders reported during any previous pregnancy (e.g., ectopic pregnancy and gestational diabetes) with potential consequences for a future pregnancy were classified as a risk factor. Detailed information on medication use was lacking, which made it impossible to classify this risk factor according to medication safety during pregnancy. Therefore, medication use was not included as a potential risk factor for adverse pregnancy outcomes.

Statistical analysis

Descriptive analyses were performed using frequencies (percentages) for categorical variables and means (standard deviation) for continuous variables. The different preconception lifestyle changes were dichotomized as any reported preconception lifestyle change (≥1 lifestyle changes) and no reported preconception lifestyle changes. Chi-square tests and independent samples t–tests were used to analyze differences in socio–demographic, health, and lifestyle characteristic distributions between women who did and did not report preconception lifestyle changes. Simple logistic regression analyses were performed to determine the association between each socio–demographic, health, and lifestyle characteristic and preconception lifestyle changes (for any and for each preconception lifestyle change). Independent variables with p≤0.10 were entered into a multiple logistic regression model for preconception lifestyle change (for any and for each preconception lifestyle change), and the results were expressed as odds ratios (OR) with 95% confidence intervals (CI). The data were screened for multicollinearity using tolerance values and variance inflation factor

(VIF). The variables "parity" and "gravity" had a tolerance lower than 0.4, possibly indicating multicollinearity between these two variables (Chan, 2004). As a result, only "parity" was selected for use in the multiple regression model. Descriptive statistics were used to analyze the prevalence of potential risk factors for adverse pregnancy outcomes, and the preconception–related information needs and sources. Results were considered statistically significant at a value of p≤0.05. Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 21 (IBM Corporation, Armonk, NY, USA).

FINDINGS

Socio-demographic, health, and lifestyle characteristics are shown in Table 1. The participant's age ranged between 21 and 39 years, with a mean age of 30 years. The majority of the women had higher education (65%), were employed (92%), and had a partner (99%). Approximately 49% of the women were nulliparous and 51% were multiparous. Overall, women who reported any preconception lifestyle changes were more likely to have higher education, experience no financial difficulties, be nulliparous, and have a history of previous miscarriage.

Table 1. Characteristics and comparison of preconception lifestyle changes of women with a planned pregnancy ending in birth (n=430)

Characteristics	All women (n=430)[a]	Any preconception lifestyle change[a,b] (n=359)	No preconception lifestyle change[a] (n=71)	P-value
Socio-demographic characteristics				
Age (years)	29.6 ± 3.9	29.7 ± 3.9	29.4 ± 3.8	0.59[j]
Belgian nationality	411 (95.6)	344 (95.8)	67 (94.4)	0.59[k]
Ethnicity: natives[c]	383 (89.1)	322 (90.2)	61 (85.9)	0.28[k]
Education[d]				
Low	148 (34.6)	116 (32.4)	32 (45.7)	0.03[k]
High	280 (65.4)	242 (67.6)	38 (54.3)	
Paid employment	392 (91.6)	328 (91.6)	64 (91.4)	0.96[k]
Net household income				
< €2.000	28 (6.8)	25 (7.2)	3 (4.5)	0.68[k]
€2.000 - €3.000	79 (19.1)	65 (18.7)	14 (20.9)	
> €3.000	307 (74.2)	257 (74.1)	50 (74.6)	
Perceived poverty: making ends meet[e]				
Easy	241 (57.8)	204 (58.1)	37 (56.1)	0.03[k]
Rather easy	125 (30.0)	107 (30.5)	18 (27.3)	
Rather difficult	44 (10.6)	37 (10.5)	7 (10.6)	
Difficult	7 (1.7)	3 (0.9)	4 (6.1)	
Perceived stress	14.7 ± 5.6	14.7 ± 5.8	14.6 ± 4.9	0.94[j]
Social support				
Low support	2 (0.5)	2 (0.6)	0 (0.0)	0.74[k]
Moderate support	129 (30.3)	109 (30.7)	20 (28.2)	
High support	295 (69.2)	244 (68.7)	51 (71.8)	

Characteristics	All women (n=430)[a]	Any preconception lifestyle change[a,b] (n=359)	No preconception lifestyle change[a] (n=71)	P-value
Partnership status				
Cohabiting relationship	423 (98.4)	353 (98.3)	70 (98.6)	0.80[k]
Non-cohabiting relationship	5 (1.2)	4 (1.1)	1 (1.4)	
Single	2 (0.5)	2 (0.6)	0 (0.0)	
Relation duration (years)	8.0 ± 3.9	8.1 ± 3.9	7.8 ± 3.9	0.65[j]
Relation satisfaction	4.7 ± 0.8	4.7 ± 0.8	4.7 ± 0.9	0.98[j]
Education partner[d]				
Low	228 (55.5)	185 (53.8)	43 (64.2)	0.12[k]
High	183 (44.5)	159 (46.2)	24 (35.8)	
Paid employment partner	404 (97.6)	336 (97.1)	68 (100.0)	0.16[k]
Intimate partner violence[f]	5 (1.2)	5 (1.4)	0 (0.0)	0.32[k]
Physical violence	2 (0.5)	2 (0.6)	0 (0.0)	0.53[k]
Sexual violence	0 (0.0)	0 (0.0)	0 (0.0)	-
Emotional violence	4 (0.9)	4 (1.1)	0 (0.0)	0.37[k]
Health and lifestyle characteristics				
Medical history				
Any chronic or serious disease[g]	34 (7.9)	31 (8.7)	3 (4.2)	0.21[k]
Drug abuse	10 (2.3)	10 (2.8)	0 (0.0)	0.16[k]
Reproductive history				
Nulligravidity	170 (39.6)	148 (41.3)	22 (31.0)	0.10[k]
Nulliparity	212 (49.4)	186 (52.0)	26 (36.6)	0.02[k]
Miscarriage	100 (23.3)	91 (25.4)	9 (12.7)	0.02[k]
Induced abortion	11 (2.6)	9 (2.5)	2 (2.8)	0.88[k]
Complicated obstetric history[h]	186 (43.4)	156 (43.6)	30 (42.3)	0.84[k]
Preconception BMI[i] (kg/m²)	24.4 ± 4.6	24.5 ± 4.7	24.1 ± 4.0	0.52[j]
Preconception smoking	41 (9.5)	31 (8.6)	10 (14.1)	0.15[k]
Preconception alcohol use	231 (54.7)	195 (54.9)	36 (53.7)	0.86[k]
Antenatal characteristics				
First prenatal visit (weeks)	9.8 ± 4.7	9.8 ± 3.1	9.5 ± 8.3	0.93[j]
Number of prenatal visits	8.7 ± 2.2	8.7 ± 1.6	8.6 ± 3.7	0.96[j]
Pregnancy weight gain (kg)	13.2 ± 5.3	13.4 ± 5.4	12.3 ± 4.8	0.16[j]
Maternal health during pregnancy				
Smoking	17 (4.0)	13 (3.6)	4 (5.7)	0.41[k]
Number of cigarettes/day	8.5 ± 3.9	8.1 ± 3.7	10.0 ± 5.0	0.47[k]
Second-hand smoke exposure	65 (15.2)	51 (14.2)	14 (20.3)	0.20[k]
Alcohol use	99 (23.4)	84 (23.6)	15 (22.4)	0.83[k]
Number of alcohol drinks/week	2.0 ± 1.6	2.0 ± 1.7	1.7 ± 1.1	0.57[j]
Drug abuse	0 (0.0)	0 (0.0)	0 (0.0)	-
Medication use	163 (38.0)	136 (38.0)	27 (38.0)	0.99[k]

[a]Data reported as mean ± standard deviation or frequencies (%); [b]≥1 preconception lifestyle changes: folic acid/multivitamin use, reduced or stopped smoking/drinking alcohol/consuming caffeine, ate more healthily, achieved a healthier weight, sought medical or health advice, took some other action; [c]One of the parents born outside Belgium; [d]Low level of education = primary, secondary or post-secondary education *versus* high level of education=college or university education; [e]Perceived poverty was measured by asking "How easy or difficult is it to make ends meet?"; [f]At least one type of violence (physical/emotional/sexual) *versus* no type of violence; [g]Asthma, diabetes mellitus, cancer, congenital, endocrine, hypertension, infectious / STI, psychiatric, epilepsy or other disease; [h]Miscarriage, mola, ectopic pregnancy, hyperemesis, gestational diabetes, urinary infection, hypertension, IUGR, placenta previa, placental abruption, HELLP, PET, preterm contractions, PPROM, instrumental vaginal delivery, shoulder dystocia, C-section, postpartum hemorrhage, sepsis, mors in utero, prematurity, small for gestational age, large for gestational age, congenital malformation, plexus brachialis, asphyxia, neonatal mortality; [i]Body Mass Index; [j]Independent-Samples t-test; [k]Chi squared test.

Associations between preconception lifestyle changes and participant characteristics

Most women (83%) who planned their pregnancy reported one or more lifestyle changes in preparation for pregnancy. The proportion of each of the seven preconception lifestyle changes is shown in figure 1.

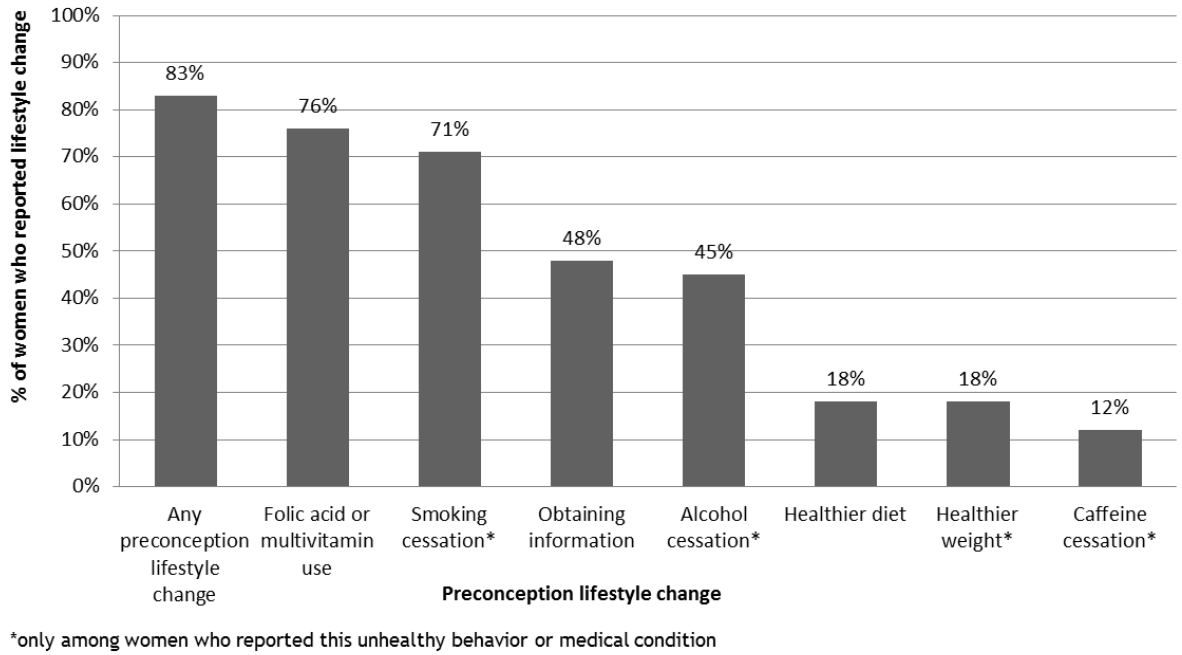


Figure 1. The proportion of preconception lifestyle changes in women with a planned pregnancy ending in birth (n=430)

The results of the multiple regression analysis revealed that women experiencing financial difficulties (OR 0.20, 95% CI 0.04 – 0.99) and women with lower educational attainment (OR 0.56, 0.32 – 0.99) were less likely to report preconception lifestyle changes, while nulliparity (OR 2.18, 95% CI 1.23 – 3.87) and a previous miscarriage (OR 2.44, 95% CI 1.14 – 5.21) increased the likelihood of preconception lifestyle changes (Table 2).

Table 2. Odds ratios (and 95% confidence intervals) for preconception lifestyle changes for women with a planned pregnancy ending in birth (n=430)

Factor	OR	95% CI	P-value
Any preconception lifestyle change			
Lower level of education[a]	0.56	0.32 – 0.99	0.05
Experiencing financial issues[b]	0.20	0.04 – 0.97	0.05
Previous miscarriage	2.44	1.14 – 5.21	0.02
Nulliparity	2.18	1.23 – 3.87	0.008
Smoking reduction or cessation			
Age (years)	1.11	0.98 – 1.27	0.10
Alcohol reduction or cessation			
Pre-pregnancy BMI[c] (kg/m²)	0.95	0.90 – 1.01	0.08
Nulliparity	1.97	1.23 – 3.16	0.05

Factor	OR	95% CI	P-value
Caffeine reduction or cessation			
Relation duration (years)	1.09	1.01 – 1.18	0.03
Pre-pregnancy alcohol use	0.48	0.26 – 0.90	0.02
Healthier diet			
Nulliparity	1.68	1.01 – 2.79	0.05
Healthier weight			
Lower level of education[a]	0.47	0.20 – 1.15	0.10
Nulliparity	1.76	0.77 – 4.02	0.18
Folic acid or (multi) vitamin use			
Lower level of education[a]	0.75	0.41 – 1.38	0.36
No paid employment	1.16	0.42 – 3.16	0.78
Lower net household income	0.65	0.29 – 1.47	0.30
Experiencing financial difficulties[b]	0.15	0.03 – 0.87	0.03
Lower level of education partner[a]	0.77	0.43 – 1.37	0.37
Previous miscarriage	2.11	1.11 – 4.01	0.03
Pre-pregnancy smoking	0.38	0.17 – 0.82	0.01
Sought medical/health advice			
Lower level of education[a]	0.82	0.47 – 1.41	0.47
No paid employment	0.56	0.23 – 1.36	0.20
Experiencing financial issues[b]	0.83	0.13 – 5.23	0.84
Lower level of education partner[a]	0.57	0.34 – 0.96	0.03
Previous miscarriage	2.18	1.29 – 3.70	0.004
Nulliparity	4.78	3.03 – 7.54	<0.001
Pre-pregnancy alcohol use	0.89	0.57 – 1.39	0.62

[a]Level of education: primary, secondary or post-secondary education; [b]Subjective poverty: making ends meet difficult or rather difficult; [c]pre-pregnancy Body Mass Index (BMI); OR, odds ratio; CI, confidence interval.

Smoking reduction or cessation. Overall, 17% (n = 75) of the sample reported cigarette smoking in the period before considering a pregnancy. Among women who smoked, 27% (n = 20) reduced smoking and 44% (n = 32) quit smoking in preparation for pregnancy. Twenty-nine percent (n = 21) of the participants did not change preconception smoking habits. The findings of the multiple regression analysis revealed that none of the characteristics were significantly associated with smoking reduction or cessation in the preconception period (Table 2).

Alcohol reduction or cessation. Overall, 76% (n = 321) of the sample reported alcohol drinking in the period before considering a pregnancy. Among women who consumed alcohol, 18% (n = 56) reduced alcohol consumption, and 27% (n = 86) quit drinking in preparation for pregnancy. Fifty-five percent (n = 175) of the participants did not change their alcohol drinking habits preconception. The multiple regression analysis showed that nulliparous women (OR 1.97, 95% CI 1.23 – 3.16) were significantly more likely to report pre-pregnancy alcohol reduction or cessation in the preconception period (Table 2).

Caffeine reduction or cessation. Fifty women (12%) reported reducing or stopping caffeine intake prior to pregnancy. A longer-term relationship (OR 1.09, 95% CI 1.01 – 1.18) increased the likelihood of caffeine reduction or cessation prior to pregnancy, while pre-pregnancy alcohol consumption (OR 0.48, 95% CI 0.26 – 0.90) significantly decreased the odds of caffeine reduction or cessation (Table 2).

Healthier diet. Almost one in five women (18%, n = 50) reported healthier eating in the preconception period. Nulliparous women (OR 1.68, 95% CI 1.01 – 2.79) were significantly more likely to report eating healthily in the preconception period (Table 2).

Healthier weight. In total, 14 women (3%) were underweight (BMI < 18.5 kg/m²), 99 women (24%) were overweight (25.0 kg/m² ≤ BMI < 30.0 kg/m²) and 46 women (11%) were obese (BMI ≥ 30.0 kg/m²) before pregnancy and, of these, 31 women (18%) reported a more healthy weight in the preconception period. The findings of the multiple regression analysis revealed that participant characteristics were not significantly associated with achieving a healthier weight in the preconception period (Table 2).

Folic acid or multivitamin supplementation. Three in four women (76%, n = 326) reported taking folic acid or multivitamin supplementation in the preconception period. Women who smoked in the preconception period (OR 0.38, 95% CI 0.17 – 0.82) and experienced financial difficulties (OR 0.15, 95% CI 0.03 – 0.87) were less likely to use folic acid or multivitamin supplementation before pregnancy, while women with a previous miscarriage (OR 2.11, 95% CI 1.11 – 4.01) were more likely to take folic acid or multivitamins preconception (Table 2).

Medical or health advice. Medical or health advice regarding preconception health was sought by 48% (n = 208) of the women. Of the women who obtained advice about preconception health, most had sought and received it from a professional caregiver. The most frequently consulted professional caregivers were the gynecologist and the general practitioner. The Internet was the second most used source for medical or health advice on preconception health. Women were especially interested in information on how to get pregnant in a healthy manner and conceiving quickly (Table 3). Findings of the multiple regression showed that nulliparous women (OR 4.78, 95% CI 3.03 – 7.54) and women with a previous miscarriage (OR 2.18, 95% CI 1.29 – 3.70) were more likely to seek medical or health advice on preconception health, while women having a partner with lower educational attainment (OR 0.57, 95% CI 0.34 – 0.96) were less likely to seek preconception-related advice.

Table 3. Content and sources of preconception health advice obtained by women with a planned pregnancy ending in birth (n=208)

Content	n (%)*
How to conceive in a healthy way	126 (60.6)
How to conceive quickly	117 (56.3)
Conceiving after a complicated pregnancy/delivery	40 (19.2)
Conceiving with/after pre-existing medical condition	15 (7.2)
Heritable or congenital disorders	14 (6.7)
Other	17 (8.2)
Fertility issues	13 (6.3)
Infection diseases	3 (1.4)
Advanced maternal age	1 (0.5)
Medication and/or medication management	22 (10.6)
Source	**n (%)***
Professional caregiver	178 (85.6)
Gynecologist	141 (67.8)
General practitioner	83 (39.9)
Medical specialist	12 (5.8)
Midwife	6 (2.9)
Internet	124 (59.6)
Friends / family	60 (28.8)
Other sources	
Books	33 (15.9)
Leaflets	25 (12.0)
Media	12 (5.8)
Other	0 (0.0)

*Percentages add up to more than 100 as women could identify multiple topics and sources.

Risk factors in women reporting no preconception lifestyle changes

Table 4 shows the prevalence of risk factors for adverse pregnancy outcomes in women who reported no preconception lifestyle changes. The most prevalent risk factors were alcohol use before pregnancy, under- or overweight, and a history of obstetric complications. About three-quarters of women reporting no preconception lifestyle changes had at least one risk factor that could influence the outcome of pregnancy, and half of the women had two or more risk factors for adverse pregnancy outcomes. Only 23% of women had no risk factors.

Table 4. Risk factors for adverse pregnancy outcomes among women with a planned pregnancy reporting no preconception lifestyle changes (n=71)

Risk factors	n (%)
Pre-pregnancy smoking	10 (14.1)
Pre-pregnancy alcohol use	36 (53.7)
Unhealthy pre-pregnancy BMI[a]	28 (43.8)
Underweight (<18.50 kg/m²)	4 (6.3)
Overweight (25.00–29.99 kg/m²)	20 (31.3)
Extreme overweight (≥ 30.00 kg/m²)	4 (6.3)
Any chronic or serious disease[b]	3 (4.2)
Complicated obstetric history[c]	30 (42.3)

Total number of women with risk factor in lifestyle and medical history (n=60)[d]	
No risk	14 (23.3)
One risk factor	14 (23.3)
Two risk factors	22 (36.7)
Three risk factors	9 (15.0)
Four risk factors	1 (1.7)

[a]Body Mass Index; [b]Asthma, diabetes mellitus, cancer, congenital, endocrine, hypertension, infectious / STI, psychiatric, epilepsy or other diseases; [c]Miscarriage, mola, ectopic pregnancy, hyperemesis, gestational diabetes, urinary infection, hypertension, IUGR, placenta previa, placental abruption, HELLP, PET, preterm contractions, PPROM, instrumental vaginal delivery, shoulder dystocia, C-section, postpartum hemorrhage, sepsis, mors in utero, prematurity, small for gestational age, large for gestational age, congenital malformation, plexus brachialis, asphyxia, neonatal mortality; [d]Sum of the risk factors mentioned above.

DISCUSSION

This study showed that most women (83%) reported one or more actions to improve their health prior to pregnancy. The most common lifestyle change in the preconception period was folic acid or multivitamin intake (76%), while dietary and body weight changes were the least reported preconception health behaviors in our study (12% – 18%). These results are in line with those of other European and US studies investigating the association between pregnancy planning and preconception lifestyle changes (Green-Raleigh et al., 2005; Chuang et al., 2010; Tyden et al., 2011; Backhausen et al., 2014; Stephenson et al., 2014; Joelsson et al., 2016; Stern et al., 2016), although the proportion of some preconception lifestyle changes, such as folic acid intake, was higher in our study. Our study reveals that nulliparous women, women with a previous miscarriage, and those of higher socio-economic status (based on level of education, income, perceived poverty, and level of education of partner) were more likely to report lifestyle changes in preparation for pregnancy. The association between socio-economic status (SES) and preconception lifestyle changes is in line with previous studies investigating preconception health behavior changes in women (Anderson et al., 2006; Timmermans et al., 2008; Chuang et al., 2011; Lipscombe et al., 2011; Cueto et al., 2012; De Santis et al., 2013; Mannien et al., 2014; Mirghafourvand et al., 2014; Stephenson et al., 2014; Joelsson et al., 2016; Poels et al., 2017). It is interesting that nulliparity increases the likelihood of preconception lifestyle changes. One would expect that multiparous women have more knowledge regarding preconception health and care compared to nulliparous mothers and, therefore, are more likely to adopt healthier preconception lifestyle. However, the results of similar studies investigating the association between preconception lifestyle changes and parity are consistent with our findings (Forster et al., 2009; Lum et al., 2011; Pandolfi et al., 2014; Stephenson et al., 2014; Poels et al., 2017). Pandolfi et al. (2014) explained this relationship by the fact that women with a previous birth may have a more "relaxed" attitude regarding preconception risks. Another important finding is the association between having had a previous miscarriage and preconception lifestyle changes. A few studies have investigated this association (Timmermans et al., 2008; Cueto et al., 2012; Delgado, 2013; Stephenson et al., 2014; Cueto et al., 2015; Navarrete-Muñoz et al., 2015), and Cueto et al. (2012) concluded that this finding may indicate a

relationship between a high desire to conceive and increased awareness of preconception health guidelines. Another possible explanation is that women who had a spontaneous abortion experienced psychological distress, such as feelings of self-blame, personal responsibility, and worry concerning their next pregnancies, which could lead to more information-seeking behavior and positive lifestyle changes in order to minimize potential pregnancy risks (Adolfsson et al., 2004; Cote-Arsenault et al., 2006).

A striking finding was the high proportion of alcohol use in the preconception period. Three quarters of the women consumed alcohol in the period before considering a pregnancy, and only 45% of these women reduced or stopped drinking alcohol in preparation for pregnancy. These results are in line with previous research (Green-Raleigh et al., 2005; Anderson et al., 2006; Tough et al., 2006; Lum et al., 2011; Backhausen et al., 2014; Stephenson et al., 2014; Gormack et al., 2015; Joelsson et al., 2016; Poels et al., 2017) and further support the need for educational campaigns concerning the risks of alcohol consumption prior to pregnancy (Tough et al., 2006).

Another interesting finding is the high proportion of women with overweight (24%) and obesity (11%), which is in line with findings of an epidemiological study in Flanders, Belgium (Guelinckx et al., 2012). Only 18% of women with an unhealthy BMI in our study reported that they aimed to achieve a healthier weight in the preconception period. In the literature, little is known about the proportion of women achieving a healthier preconception weight and its associated factors. Gormack et al. (2015) found 13% of women undergoing a fertility treatment reported a reduced BMI due to upcoming fertility treatment. Joelsson et al. (2016) investigated changes in physical activity and dietary habits in sub-fertile women. Of the sub-fertile women included in their study, 32% exercised more and 21% changed to healthy diets (Joelsson et al., 2016). None of the studies found a significant association with demographics. It would be of interest to further explore this topic. Pre-pregnancy weight status is an important component of preconception care recommendations because it can have a major influence on maternal and neonatal outcomes (Jack et al., 2008; Bogaerts et al., 2013; Temel et al., 2015; Frayne et al., 2016).

Most women (77%) who did not report any preconception lifestyle changes had one or more risk factors for adverse pregnancy outcomes, which is consistent with the prevalence (77%) reported by Joelsson et al. (2016). However, Joelsson et al. (2016) did not make a distinction between sub-fertile women who did and did not report preconception lifestyle changes. Another study (van der Pal-de Bruin et al., 2008) found that all of the 481 couples who were offered a preconception counseling program had one or more risk factors. This higher prevalence may be explained by differences in the study population (couples versus women only), study design (prospective versus retrospective design), and risk-assessments tools (extensive versus concise). Consistent with the study by van der Pal-de Bruin et al. (2008), our results indicate that lifestyle factors (such as alcohol

use and unhealthy BMI) were the most prevalent risk factors. It would be interesting to further explore why women at risk for adverse pregnancy outcomes do not avoid these risks. A recent systematic review identified several barriers regarding the use of preconception care, including lack of pregnancy planning, perceived absence of risks, and lack of awareness of preconception care (Poels et al., 2016). It would be of interest to further explore if these or other barriers are also present in women who are trying to conceive but do not change their lifestyle to reduce risk factors that may influence pregnancy outcomes. The use of a qualitative research design would be an appropriate approach to gain insight in perceived barriers as qualitative methods explore topics more in-depth and detail than quantitative research.

This study has some limitations. First, preconception lifestyle changes were assessed through retrospective (after birth) self-report, which might have led to recall bias. Second, the questionnaire only included items on achieving a healthier diet and reducing caffeine intake before pregnancy, but none on women's regular nutrition and caffeine intake. This makes it difficult to assess whether an unchanged diet in the preconception period is the result of an already healthy lifestyle or whether it is a continuation of an unhealthy diet. Moreover, information on cigarette smoking (number of cigarettes/day) and alcohol intake (number of drinks/week) during the preconception period is lacking as the questionnaire only assessed frequency and quantity of smoking and alcohol use during pregnancy. In addition, detailed information on medication use was lacking, which made it impossible to classify medications according to their safety during pregnancy. As a result, medication use was not included as a potential risk factor for adverse pregnancy outcomes in women reporting no preconception lifestyle changes. Third, inferential statistics were not always possible or meaningful due to low frequencies (e.g., number of induced abortions, drug abuse, and IPV), which made it impossible to identify all associations between independent variables and preconception lifestyle changes. Lastly, only women with an understanding of written Dutch were included in the study, leading to selection bias. In addition, the response rate for this study was only 22%, limiting the ability to generalize the results to the general population. Our participant demographics' (education, income, employment, marital status, and nationality) confirm an overrepresentation of women with higher SES. Therefore, the proportion of preconception lifestyle changes may be overestimated as pre-pregnancy behavior is associated with higher SES as reported by other studies. This study has several strengths. To the authors' knowledge, this is one of the first studies to investigate a broad range of preconception lifestyle changes in a general population of women with a planned pregnancy in a comprehensive manner. Other strengths include the use of validated and reliable instruments to measure pregnancy planning and an extensive data set on women's socio-demographic, health, and lifestyle characteristics. These findings have implications for public health interventions and policy. It would be relevant to establish a national campaign to promote preconception

health in couples planning a pregnancy. The strategies for promoting preconception health should be tailored to specific subgroups (Levis and Westbrook, 2013; Squiers et al., 2013). Our results indicate that nulliparous women, those with a previous miscarriage, and women of higher SES are more likely to report lifestyle changes before pregnancy, so it is possible that these women are more receptive to preconception health and health care messages. Professional caregivers play an important role in promoting preconception care. Of the women who obtained preconception-related advice, the majority (86%) received the advice from a professional caregiver. These results are consistent with the findings of Goossens et al. (2016b) and Frey and Files (2006) but are contrary to the findings of Poels et al. (2017) and Stephenson et al. (2014) who found that less than 25% and 30% consulted a healthcare provider in preparation for pregnancy, respectively. Most of the women in our study received information from a gynecologist or general practitioner, and only 3% received information from a midwife, which can be explained by the fact that routine (pre-)pregnancy care for women is predominantly provided by gynecologists in Belgium (Emons and Luiten, 2001). However, a midwife is one of the most appropriate professional caregivers to provide preconception health advice as she is trained to provide primary and preventive pregnancy-related care to women and couples (Johnson et al., 2006). National guidelines on preconception care would be helpful to support professional caregivers in informing and promoting preconception health behavior in women planning a pregnancy. Our findings also indicate that multiparous women and women of lower SES are less likely to change their preconception lifestyle. Strategies to promote preconception health in these women will probably be more complex and difficult as there are more barriers to overcome. It may be interesting to reach these women through non-medical channels, such as schools for example, via the implementation of preconception health in sexual education programs. The rationale for this strategy is that habits and attitudes are formed at a young age and, moreover, schools have the potential for reaching the vast majority of the population, including "difficult to reach" groups, thanks to compulsory education (Fujimori et al., 2008; Angell et al., 2011; Delgado, 2013). To strengthen the evidence basis of future interventions on preconception health, further research is required to understand societal and individual determinants of preconception health behaviors. Several studies and interventions on preconception health have been focused on knowledge alone (Toivonen et al., 2016), while preconception health knowledge does not necessarily lead to behavior change (Delissaint and McKyer, 2011). Therefore, it would be interesting to investigate which determinants have an influence on preconception health intention and behaviors. Future research should include both men and women as participants as well as socially vulnerable groups (Toivonen et al., 2016). The latter groups often have poorer health status and more risk behavior that could lead to adverse pregnancy outcomes and, therefore, could benefit greatly from preconception health care (Johnson et al., 2006; de Graaf et al., 2013; Larrañaga et al., 2013).

REFERENCES

Adolfsson A, Larsson PG, Wijma B, Bertero C (2004) Guilt and emptiness: women's experiences of miscarriage. Health care for women international 25:543-560.

Anderson JE, Ebrahim S, Floyd L, Atrash H (2006) Prevalence of risk factors for adverse pregnancy outcomes during pregnancy and the preconception period--United States, 2002-2004. Matern Child Health J 10:S101-106.

Angell C, Alexander J, Hunt JA (2011) How are babies fed? A pilot study exploring primary school children's perceptions of infant feeding. Birth (Berkeley, Calif) 38:346-353.

Backhausen MG, Ekstrand M, Tyden T, Magnussen BK, Shawe J, Stern J, Hegaard HK (2014) Pregnancy planning and lifestyle prior to conception and during early pregnancy among Danish women. Eur J Contracept Reprod Health Care 19:57-65.

Barrett G, Smith SC, Wellings K (2004) Conceptualisation, development, and evaluation of a measure of unplanned pregnancy. J Epidemiol Community Health 58:426-433.

Bartholomew LK, Parcel GS, Kok G, Gottlieb NH, Fernàndez ME (2011) Planning health promotion programs: An intervention mapping approach., 3 Edition. San Fransisco: Jossey -Bass.

Bogaerts A, Van den Bergh BR, Ameye L, Witters I, Martens E, Timmerman D, Devlieger R (2013) Interpregnancy weight change and risk for adverse perinatal outcome. Obstet Gynecol 122:999-1009.

Borges AL, Santos OA, Nascimento Nde C, Chofakian CB, Gomes-Sponholz FA (2016) Preconception health behaviors associated with pregnancy planning status among Brazilian women. Revista da Escola de Enfermagem da U S P 50:208-216.

Chan Y (2004) Biostatistics 201: linear regression analysis. Age (years) 80:140.

Chuang CH, Hillemeier MM, Dyer A-M, Weisman CS (2011) The relationship between pregnancy intention and preconception health behaviors. Preventive medicine 53:85-88.

Chuang CH, Weisman CS, Hillemeier MM, Schwarz EB, Camacho FT, Dyer A-M (2010) Pregnancy intention and health behaviors: results from the Central Pennsylvania Women's Health Study cohort. Maternal and child health journal 14:501-510.

Cohen S, Kamarck T, Mermelstein R (1983) A global measure of perceived stress. Journal of health and social behavior 24:385-396.

Cote-Arsenault D, Donato KL, Earl SS (2006) Watching & worrying: early pregnancy after loss experiences. MCN The American journal of maternal child nursing 31:356-363.

Cueto HT, Riis AH, Hatch EE, Wise LA, Rothman KJ, Mikkelsen EM (2012) Predictors of preconceptional folic acid or multivitamin supplement use: a cross-sectional study of Danish pregnancy planners. Clinical epidemiology 4:259-265.

Cueto HT, Riis AH, Hatch EE, Wise LA, Rothman KJ, Sørensen HT, Mikkelsen EM (2015) Folic acid supplement use and menstrual cycle characteristics: a cross-sectional study of Danish pregnancy planners. Annals of Epidemiology 25:723-729. e721.

de Graaf JP, Steegers EA, Bonsel GJ (2013) Inequalities in perinatal and maternal health. Current Opinion in Obstetrics and Gynecology 25:98-108.

De Santis M, Quattrocchi T, Mappa I, Spagnuolo T, Licameli A, Chiaradia G, De Luca C (2013) Folic acid use in planned pregnancy: an Italian survey. Matern Child Health J 17:661-666.

Delgado C (2013) Pregnancy 101: a call for reproductive and prenatal health education in college. Matern Child Health J 17:240-247.

Delissaint D, McKyer ELJ (2011) A systematic review of factors utilized in preconception health behavior research. Health Education & Behavior 38:603-616.

Emons J, Luiten M (2001) Midwifery in Europe. The European Midwives Liaison Committee, The Netherlands.

Forster DA, Wills G, Denning A, Bolger M (2009) The use of folic acid and other vitamins before and during pregnancy in a group of women in Melbourne, Australia. Midwifery 25:134-146.

Frayne DJ, Verbiest S, Chelmow D, Clarke H, Dunlop A, Hosmer J, Menard MK, Moos MK, Ramos D, Stuebe A, Zephyrin L (2016) Health Care System Measures to Advance Preconception Wellness: Consensus Recommendations of the Clinical Workgroup of the National Preconception Health and Health Care Initiative. Obstet Gynecol 127:863-872.

Frey KA, Files JA (2006) Preconception healthcare: what women know and believe. Matern Child Health J 10:S73-77.

Fujimori M, Morais TC, Franca EL, de Toledo OR, Honorio-Franca AC (2008) The attitudes of primary school children to breastfeeding and the effect of health education lectures. Jornal de pediatria 84:224-231.

Gipson JD, Koenig MA, Hindin MJ (2008) The effects of unintended pregnancy on infant, child, and parental health: a review of the literature. Studies in family planning 39:18-38.

Goossens J, Van Den Branden L, Van der Sluys L, Delbaere I, Van Hecke A, Verhaeghe S, Beeckman D (2016a) The prevalence of unplanned pregnancy ending in birth, associated factors, and health outcomes. Human Reproduction

Goossens J, Delbaere I, Dhaenens C, Willems L, Van Hecke A, Verhaeghe S, Beeckman D (2016b) Preconception-related needs of reproductive-aged women. Midwifery 33:64-72.

Goossens JNATV (2017) Psychometric properties of the Dutch London Measure of Unplanned Pregnancy in women with pregnancies ending in birth.

Gormack AA, Peek JC, Derraik JG, Gluckman PD, Young NL, Cutfield WS (2015) Many women undergoing fertility treatment make poor lifestyle choices that may affect treatment outcome. Hum Reprod 30:1617-1624.

Green-Raleigh K, Lawrence JM, Chen H, Devine O, Prue C (2005) Pregnancy planning status and health behaviors among nonpregnant women in a California managed health care organization. Perspectives on sexual and reproductive health 37:179-183.

Guelinckx I, Devlieger R, Bogaerts A, Pauwels S, Vansant G (2012) The effect of pre-pregnancy BMI on intention, initiation and duration of breast-feeding. Public health nutrition 15:840-848.

Inskip HM, Crozier SR, Godfrey KM, Borland SE, Cooper C, Robinson SM (2009) Women's compliance with nutrition and lifestyle recommendations before pregnancy: general population cohort study. Bmj 338:b481.

Jack BW, Atrash H, Coonrod DV, Moos MK, O'Donnell J, Johnson K (2008) The clinical content of preconception care: an overview and preparation of this supplement. Am J Obstet Gynecol 199:S266-279.

Joelsson LS, Berglund A, Wanggren K, Lood M, Rosenblad A, Tyden T (2016) Do subfertile women adjust their habits when trying to conceive? Ups J Med Sci 121:184-191.

Johnson K, Posner SF, Biermann J, Cordero JF, Atrash HK, Parker CS, Boulet S, Curtis MG (2006) Recommendations to improve preconception health and health care—United States. Morbidity and Mortality Weekly Report 55:1-23.

Larrañaga I, Santa-Marina L, Begiristain H, Machón M, Vrijheid M, Casas M, Tardón A, Fernández-Somoano A, Llop S, Rodriguez-Bernal CL (2013) Socio-economic inequalities in health, habits and self-care during pregnancy in Spain. Maternal and child health journal 17:1315-1324.

Lassi ZS, Imam AM, Dean SV, Bhutta ZA (2014) Preconception care: caffeine, smoking, alcohol, drugs and other environmental chemical/radiation exposure. Reprod Health 11 Suppl 3:S6.

Levis DM, Westbrook K (2013) A content analysis of preconception health education materials: characteristics, strategies, and clinical-behavioral components. American Journal of Health Promotion 27:S36-S42.

Lipscombe LL, McLaughlin HM, Wu W, Feig DS (2011) Pregnancy planning in women with pregestational diabetes. The journal of maternal-fetal & neonatal medicine : the official journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstet 24:1095-1101.

Lum KJ, Sundaram R, Buck Louis GM (2011) Women's lifestyle behaviors while trying to become pregnant: evidence supporting preconception guidance. Am J Obstet Gynecol 205:203.e201-207.

Mannien J, de Jonge A, Cornel MC, Spelten E, Hutton EK (2014) Factors associated with not using folic acid supplements preconceptionally. Public Health Nutr 17:2344-2350.

Mirghafourvand M, Sehhati F, Rahimi M (2014) Health-promoting Lifestyle and its Demographic Predictors in Infertile Couples Referred to Infertility Clinic of Tabriz Al-Zahra Hospital, 2013. Journal of caring sciences 3:175-184.

Mohllajee AP, Curtis KM, Morrow B, Marchbanks PA (2007) Pregnancy intention and its relationship to birth and maternal outcomes. Obstetrics and gynecology 109:678-686.

Navarrete-Muñoz EM, Valera-Gran D, de la Hera MG, Gimenez-Monzo D, Morales E, Julvez J, Riaño I, Tardón A, Ibarluzea J, Santa-Marina L (2015) Use of high doses of folic acid supplements in pregnant women in Spain: an INMA cohort study. BMJ open 5:e009202.

Pandolfi E, Agricola E, Gonfiantini MV, Gesualdo F, Romano M, Carloni E, Mastroiacovo P, Tozzi AE (2014) Women participating in a web-based preconception study have a high prevalence of risk factors for adverse pregnancy outcomes. BMC pregnancy and childbirth 14:169.

Poels M, van Stel HF, Franx A, Koster MPH (2017) Actively preparing for pregnancy is associated with healthier lifestyle of women during the preconception period. Midwifery 50:228-234.

Poels M, Koster MP, Boeije HR, Franx A, van Stel HF (2016) Why Do Women Not Use Preconception Care? A Systematic Review On Barriers And Facilitators. Obstet Gynecol Surv 71:603-612.

Shah PS, Balkhair T, Ohlsson A, Beyene J, Scott F, Frick C (2011) Intention to become pregnant and low birth weight and preterm birth: a systematic review. Matern Child Health J 15:205-216.

Squiers L, Mitchell EW, Levis DM, Lynch M, Dolina S, Margolis M, Scales M, Kish-Doto J (2013) Consumers' perceptions of preconception health. American Journal of Health Promotion 27:S10-S19.

Stephenson J, Patel D, Barrett G, Howden B, Copas A, Ojukwu O, Pandya P, Shawe J (2014) How do women prepare for pregnancy? Preconception experiences of women attending antenatal services and views of health professionals. PloS one 9:e103085.

Stern J, Joelsson LS, Tyden T, Berglund A, Ekstrand M, Hegaard H, Aarts C, Rosenblad A, Larsson M, Kristiansson P (2016) Is pregnancy planning associated with background characteristics and pregnancy-planning behavior? Acta Obstet Gynecol Scand 95:182-189.

Temel S, van Voorst SF, de Jong-Potjer LC, Waelput AJ, Cornel MC, de Weerd SR, Denktaş S, Steegers EA (2015) The Dutch national summit on preconception care: a summary of definitions, evidence and recommendations. Journal of community genetics 6:107.

Timmermans S, Jaddoe VW, Mackenbach JP, Hofman A, Steegers-Theunissen RP, Steegers EA (2008) Determinants of folic acid use in early pregnancy in a multi-ethnic urban population in The Netherlands: the Generation R study. Preventive medicine 47:427-432.

Toivonen KI, Oinonen KA, Duchene KM (2016) Preconception Health Behaviours: A Scoping Review. Preventive Medicine.

Tough S, Tofflemire K, Clarke M, Newburn-Cook C (2006) Do women change their drinking behaviors while trying to conceive? An opportunity for preconception counseling. Clinical Medicine & Research 4:97-105.

Tyden T, Stern J, Nydahl M, Berglund A, Larsson M, Rosenblad A, Aarts C (2011) Pregnancy planning in Sweden--a pilot study among 270 women attending antenatal clinics. Acta Obstet Gynecol Scand 90:408-412.

van der Pal-de Bruin KM, le Cessie S, Elsinga J, de Jong-Potjer LC, van Haeringen A, Neven AK, Verloove-Vanhorick SP, Assendelft P (2008) Pre-conception counselling in primary care: prevalence of risk factors among couples contemplating pregnancy. Paediatr Perinat Epidemiol 22:280-287.

van Voorst SF, Ten Kate CA, de Jong-Potjer LC, Steegers EAP, Denktas S (2017) Developing social marketed individual preconception care consultations: Which consumer preferences should it meet? Health Expect.

World Health Organization (2000) Obesity: preventing and managing the global epidemic: World Health Organization.

World Health Organization (2013) Meeting to develop a global consensus on preconception care to reduce maternal and childhood mortality and morbidity: World Health Organization Headquarters, Geneva, 6–7 February 2012: meeting report.

Zimet GD, Dahlem NW, Zimet SG, Farley GK (1988) The multidimensional scale of perceived social support. Journal of personality assessment 52:30-41.

CHAPTER 6

SOCIO-DEMOGRAPHIC AND PSYCHOSOCIAL FACTORS ASSOCIATED WITH WOMEN'S INTENTION TO PREPARE FOR PREGNANCY: A CROSS-SECTIONAL STUDY

Based on the article of Goossens, J., Van Hecke, A., Beeckman, D.*, Verhaeghe, S.* (2018). Socio-demographic and psychosocial factors associated with women's intention to prepare for pregnancy: a cross-sectional study. Submitted to International Journal of Nursing Studies. Category NURSING: 1/115 (Q1) – IF: 3.66. *Shared last authorship.

ABSTRACT

BACKGROUND: Despite growing evidence of the importance of preconception health and care, many women do not prepare for pregnancy. It is important to gain insight into factors associated with preconception health behaviors or behavioral intentions.

AIM: To identify socio-demographic and psychosocial factors associated with the overall intention to prepare for pregnancy and specific preconception lifestyle changes in the general population of reproductive-aged women.

METHODS: A questionnaire was developed and validated to assess the intention, self-efficacy, attitude, social influence, knowledge, and barriers towards 9 preconception health behaviors (living a healthy life, taking folic acid daily, eating healthy, preventing foodborne illness, searching information, alcohol and smoking cessation, losing weight, discussing medication/herb use). A convenience sample of 1722 women was recruited between July 2015 and July 2016 from different settings, and online. Descriptive, simple, and multiple regression analyses were performed.

FINDINGS: A positive attitude (p<0.001), self-efficacy (p<0.001), and higher knowledge scores (p=0.01) were associated with higher intention to prepare for pregnancy. Experiencing barriers, including negative emotions and beliefs (p<0.001) and lack of perceived need for preconception lifestyle changes (p=0.03) was associated with less intention to prepare for pregnancy. Religion as a barrier to prepare for pregnancy (p=0.01), nulliparity (p<0.001) and having a normal weight (p<0.001) were associated with a higher intention. This model explained 30% of the variance of the preconception behavioral intention.

DISCUSSION: Preconception interventions should address the identified associated factors to enhance preconception lifestyle changes. Future research should explore the most appropriate intervention methods and strategies, depending on the context and population.

Key words: ASE model; Behavior and Behavior Mechanisms; Associated factors; Intention; Preconception care; Preconception behavior.

Statement of Significance

Problem

Little is known about associated psychosocial factors of the intention to prepare for pregnancy in reproductive-aged women.

What is Already Known

There are several socio-demographic factors associated with preconception lifestyle changes, including educational level, income, insurance status, and parity.

What this Paper Adds

An overview of modifiable factors associated with the intention to prepare for pregnancy, including self-efficacy, attitude, knowledge, and barriers. These associated factors should be addressed in preconception health interventions to enhance preconception lifestyle changes in women wanting to conceive.

INTRODUCTION

Preconception care is a type of primary prevention to future offspring, and primary, secondary, and tertiary prevention to parents-to-be (Johnson et al., 2006; Temel et al., 2015). It can be defined as "A set of interventions and/or programs that aims to identify and enable informed decision-making to modify biomedical, behavioral, and (psycho)social risks to parental health and the health of their future child, through counseling, prevention and management, emphasizing those factors that must be acted on before conception and in early pregnancy, to have maximal impact and/or choice" (Temel et al., 2015). The basic idea of preconception care is to assure that a woman and man are healthy before they become pregnant to improve pregnancy outcomes (Johnson et al., 2006; Temel et al., 2015). Previous research has shown that improving preconception health and reducing parental risk factors can lead to improved reproductive outcomes and reduced maternal and childhood mortality and morbidity (Korenbrot et al., 2002; Johnson et al., 2006; Shannon et al., 2013). Despite growing evidence in support of the importance of preconception health and care, many women do not prepare for pregnancy (Poels et al., 2016). In order to develop interventions to improve the uptake of preconception health and care, it is important to gain insight in factors influencing preconception behavior or behavioral intentions (Bartholomew et al., 2011). However, research on factors is limited to studies of socio-demographic factors associated with preconception health behavior (Stephenson et al., 2014; Joelsson et al., 2016; Toivonen et al., 2017; Goossens et al., 2018). Hardly any studies have been conducted on psychosocial factors associated with preconception health behavior or behavioral intentions in the general population. The exceptions are studies on use of preconception care and folic acid, which are only two preconception health behaviors. For example, the cross-sectional study of Temel et al. (2013) investigated which factors were associated with the intention to use preconception care in a multi-ethnic population in the Netherlands. They found that a positive attitude ($p<0.001$) and experiencing few barriers to use preconception care ($p=0.003$) were associated with the a higher intention to use preconception care. To the author's knowledge, studies on psychosocial factors associated with other preconception lifestyle changes, such as smoking and alcohol cessation, and with the overall intention to prepare for pregnancy are lacking. Therefore, the aim of this study was to identify socio-demographic and psychosocial factors associated with the overall

intention to prepare for pregnancy and specific preconception lifestyle changes in a general population of reproductive-aged women.

PARTICIPANTS, ETHICS AND METHODS

Design

A cross-sectional, multicenter study was performed to gain insight into socio-demographic and psychosocial factors associated with preconception health behavioral intentions. The study included a one-time, anonymous questionnaire about preconception health and lifestyle changes. Ethical approval for the study was obtained from the Ethical Committee Ethical Committee of Ghent University Hospital (B670201422053).

Sample

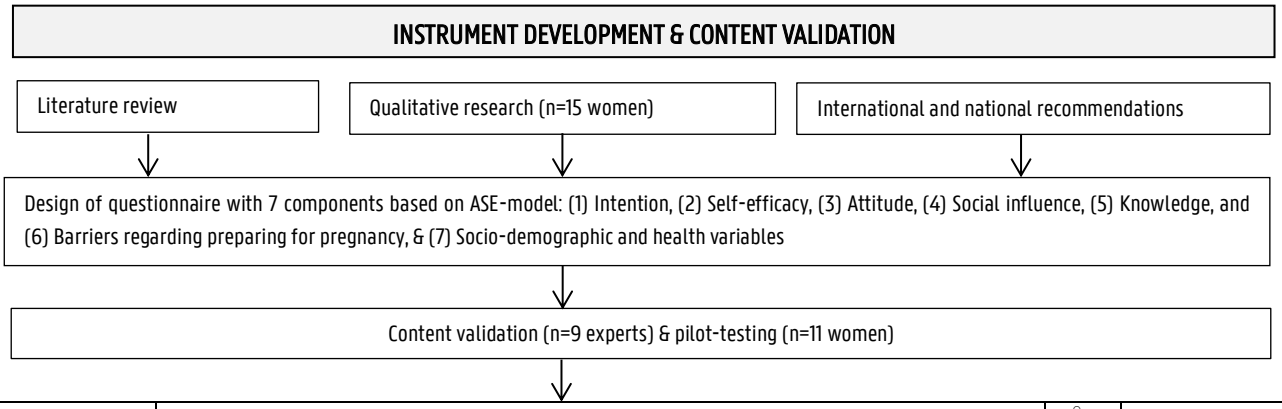
Women aged 15 – 45, who want to have (more) children, and able to read Dutch or English were invited to participate in this study. Women who have a low socioeconomic status (SES) are often hard-to-reach, and therefore, underrepresented in research (Freimuth and Mettger, 1990). In an attempt to obtain a representative sample, women were recruited from a convenience sample of several settings including places with a high proportion of women of lower SES. The participants in this study were recruited between July 2015 and July 2016 from 7 Community Health Centers, 4 Public Centers for Social Welfare ('OCMW'), 1 youth welfare organization, 4 secondary schools (general/ technical/ vocational secondary education; 4^{th} – 7^{th} year), 1 private company, and through social media and websites of public agencies and other organizations in Flanders (northern region of Belgium).

Instrument development & content validity

Based on a literature review, a qualitative research, and (inter)national recommendations on preconception health and healthcare (Delbaere et al., 2016; Jack et al., 2008; Johnson et al., 2006; Samyn et al., 2008), an overview of socio-demographic and psychosocial factors was made. Subsequently, a conceptual framework was developed based on the Attitude – Social Influence – Self-efficacy (ASE) model (de Vries et al., 1988; Devries and Backbier, 1994; Lechner and Devries, 1995; De Vries et al., 1998). The ASE-model suggests that intention to perform a particular behavior predicts this behavior. The behavioral intention is determined by three important psychosocial determinants: attitude, social influence, and self-efficacy. Barriers and skills play a role when the behavior is performed (de Vries et al., 1988; Lechner and Devries, 1995). The ASE-model has been widely used to explain health behavior change, including testicular self-examination (Lechner et al., 2002), breast cancer screening (Lechner et al., 1997), smoking cessation (Devries and Backbier, 1994), fruit and

vegetable consumption (Brug et al., 1995; Brug et al., 2006), physical activity (Hopman-Rock et al., 2005), and preconception care use (Temel et al., 2013).

The face- and content validity of the initial questionnaire were assessed in a Delphi procedure with a panel of 9 national and international experts with clinical and/or academic expertise in preconception health, nursing, and/or health promotion. After the second round, the questionnaire was judged to have excellent face and content validity, with a content validity index (CVI) ranging from 0.80 to 1.00 (Polit and Beck, 2010). The clarity of wording, ambiguity in meaning, and format of the questionnaire were assessed in a pilot study including 11 women who met the inclusion criteria using cognitive interviewing techniques. The women had a mean age of 25,4 years with a range of 15 to 32 years. Two women were students of secondary schools, three women had a secondary education, and six women had college or university education. No immigrant women were interviewed. The final questionnaire consisted of 90 items, grouped in 7 scales. An overview of the instrument development and content validation is presented in Figure 1. The questionnaire was available in Dutch and English, and took 15 – 20 minutes to complete.



Component	*Description*	*N° of items*	*Response category*
Intention	Planning to perform lifestyle changes before becoming pregnant. Intention was assessed by asking, "Will you make this preparation? (*=Do you plan to make this preparation before you become pregnant?)*". 9 PC lifestyle changes were assessed: 5 general PC lifestyle changes (living a healthy life, searching information/advice on how to become pregnant in a healthy way; taking folic acid daily; steps to prevent foodborne illness; eating healthy) and 4 specific PC lifestyle changes for women reporting this unhealthy behavior/medical condition (stop smoking; stop drinking alcohol; losing weight; discussing medication/herb use with HC provider)[a].	9	'Yes', 'No', 'Not applicable'[b]
Self-efficacy	The belief in the ability to perform lifestyle changes before becoming pregnant. Self-efficacy was assessed by asking, "Can you make this preparation? *(= Do you think you are able to make this preparation, regardless whether or not you plan to make it?)*". 9 PC lifestyle changes were assessed: 5 general and 4 specific PC lifestyle changes[a].	9	'Yes', 'No', 'Not applicable'[b]
Attitude	Beliefs about consequences of performing lifestyle changes before becoming pregnant. Attitudes were measured by asking to score several beliefs about the positive and negative consequences of preparing for pregnancy.	9	6-point Likert scale: Completely disagree – Completely agree
Social influence	The normative beliefs of important others about preparing for pregnancy and the motivation to comply with important others' beliefs, pressure or support from others to perform lifestyle changes before becoming pregnant, and whether important others would perform lifestyle changes before becoming pregnant. Social influences of (1) the close social environment (partner, family, friends, colleagues or fellow students), (2) healthcare providers, and (3) media were measured. (4) The importance of others' opinion about PC lifestyle changes was assessed by asking women to rate how important the opinion of their close social environment and professional caregivers is for them.	6 5	6-point Likert scale: Completely disagree –Completely agree 5-point Likert scale: Very unimportant – Very important
Knowledge	Knowledge was assessed with a true- false scale assessing knowledge about (1) tobacco, alcohol, and substance abuse, (2) nutrition, (3) family planning, (4) medication, and (5) infection diseases and immunization.	17	'True', 'False', 'I don't know'[b]
Barriers	Obstacles that make it difficult to perform lifestyle changes before pregnancy. Costs, religion, health literacy, wish for secrecy, stress, scare away partner, negative influence fertility, perceived need, and medicalization of conception were included as barriers to preparing for pregnancy.	10	6-point Likert scale: Completely disagree – Completely agree
Socio-demographic and health-related variables	Sex, age, nationality, country of origin, parents' country of origin, religion, language proficiency, marital status, living situation, biological children, home environment, desire for children, smoking habits, alcohol consumption, height, weight, general health, medical condition, medication use, social support, educational level, paid employment, income, perceived poverty.	24	Depending on question

[a]Analyses were only performed on women who reported this unhealthy behavior or medical condition; [b]Response categories were dichotomized for analysis: 'yes' *versus* 'no'/'not applicable'(general PC lifestyle changes were applicable for all women) and 'correct' *versus* 'incorrect'/'I don't know' answer on knowledge items. Abbreviations, HC: healthcare; PC: preconception.

Figure 1. Overview of the instrument development and content validation

Instrument validation

After the data-collection was completed, a psychometric evaluation of the questionnaire was conducted in an age–, level of education–, and ethnicity–stratified random sample of 193 women. The psychometric validation included the evaluation of the construct validity and the reliability. Overall, the questionnaire showed

acceptable construct validity and internal consistency with only minor modifications required. The results of psychometric evaluation are presented in Figure 2.

PSYCHOMETRIC EVALUATION

Construct validity:
1. Principal component analysis[a]
2. known-groups technique (Mann-Whitney U & Kruskal Wallis test)[b]
3. Item validity (knowledge): item difficulty & discrimination index[c]

Reliability:
1. internal consistency (*Cronbach's α*)[d]
2. inter-item correlations (*r*)[e]
3. item-total correlations (*r*)[f]

Component	*Construct validity*	*Reliability*
Intention	1. Not applicable (ǂ PC lifestyle changes) 2. Hypothesis confirmed: higher level of education, nulliparity, age, native ethnicity, non-smoking, fertility treatment were positively associated with higher intention (p-value: 0.01 – <0.001)	1. Not applicable (ǂ PC lifestyle changes) 2. Not applicable (ǂ PC lifestyle changes) 3. Not applicable (ǂ PC lifestyle changes)
Self-efficacy	1. Not applicable (ǂ PC lifestyle changes) 2. Hypothesis confirmed: higher level of education, nulliparity, age, native ethnicity, income, non-smoking, and active desire for children were positively associated with higher self-efficacy (p-value: 0.007 – <0.001)	1. Not applicable (ǂ PC lifestyle changes) 2. Not applicable (ǂ PC lifestyle changes) 3. Not applicable (ǂ PC lifestyle changes)
Attitude	1. 6 items loaded onto 1 component, factor loadings: 0.49 – 0.73. The other 3 items loaded onto the 'barriers' component, and therefore, were analyzed as barriers to preparing for pregnancy. 2. Hypothesis confirmed: higher level of education and non-smoking were positively associated with a more positive attitude (p-value: 0.008 – <0.001)	1. α = 0.69 2. All positive correlations 3. *r*= 0.31–0.49
Social influence	1. 4 items on the social influence of the close social environment (partner, friends, family, colleagues or fellow students) loaded onto 1 component (factor loadings: 0.54 – 0.89). The item on social influence of healthcare providers and social pressure of media were analyzed separately. The 5 items on the importance of the other's opinion about PH behaviors loaded onto 1 component (factor loadings: 0.65 – 0.70). 2. Hypothesis confirmed (social influences): younger age and having no biological children were positively associated with more social influence (p-value: 0.01 – 0.02). Hypotheses confirmed (importance of opinion):/	1. α = 0.81 (social influence environment); α = 0.68 (importance others' opinion) 2. All positive correlations 3. *r* (social influence environment)= 0.36–0.75 *r* (importance others' opinion)= 0.42–0.47
Knowledge	1. Not applicable (ǂ topics on PH) 2. Hypothesis confirmed: higher level of education, nulliparity, age, paid employment, income, and active desire for children were positively associated with higher knowledge (p-value: 0.002 – <0.001) 3. Item difficulty: 33% – 89%; Discrimination index: 0.23 – 0.75	1. Not applicable (ǂ topics on PH) 2. Not applicable (ǂ topics on PH) 3. Not applicable (ǂ topics on PH)
Barriers	1. The items loaded onto 5 components: (1) health literacy, 5 items, factor loadings: 0.58 – 0.84; (2) emotions and beliefs, 5 items, factor loadings: 0.50 – 0.71; (3) religion, 1 item; (4) financial issues, 1 item; (5) perceived need, 1 item. 2. Hypothesis confirmed (health literacy): higher level of education, age, paid, non-smoking, and active desire for children were negatively associated with perceiving less barriers (p-value: 0.001 – <0.001); Hypothesis confirmed (emotions and belief):/	1. α (health literacy)= 0.80; α (emotions and beliefs)= 0.66 2. All positive correlations 3. *r* (health literacy)= 0.41–0.70; *r* (emotions and beliefs)= 0.27–0.44

[a]Factor analysis using principal component analysis with varimax rotation. Sample adequacy was confirmed by Kaiser-Meyer-Olkin test (>0.50) and Bartlett's test of sphericity ($p<0.05$). The number of factors (eigenvalues ≥1) and factor loadings (>0.40) were evaluated; [b]hypotheses were formulated based on a literature review on associated factors of preconception health behavior. Literature on associated factors of self-efficacy, attitude, social influences, and barriers regarding preparing for pregnancy was scare. Therefore, hypothesis were based on literature about associated factors of preconception knowledge, intention and behavior (educational level, parity, age, income, paid employment, ethnicity, partnership status, smoking behavior, fertility treatment, and desire for children); [c]Item difficulty (ID): % of respondents who answered question correctly, values recommended for ID are between 10% and 90%, Discriminating index (DI): % of correct answers in the top 27% of respondents with highest score *minus* % of correct answers in lowest 27% of respondents with lowest score, DI values of 0.20-0.29 are considered as acceptable, 0.30-0.39 as good and 0.40 and above as excellent (Ebel, 1972); [d]Cronbach's α higher than 0.70 is considered as acceptable (Polit and Beck, 2010); [e]All items should be positively intercorrelated; [f]Scores above 0.2 indicating an acceptable correlation between each item and the overall score (Streiner et al., 2014); Abbreviations, PC: preconception; PH: preconception health.

Figure 2. Overview of the psychometric evaluation

Procedure

Five different recruitment procedures were followed to gain access to all relevant populations targeted in this study. Firstly, posters in the waiting rooms of the Community Health Centers and Public Centers for Social Welfare invited women to take a paper questionnaire, to complete and deposit it in a collection box at the site while they were waiting for their appointment. Respectively, 76 and 12 women were recruited via this method. Secondly, 11 secondary schools in Flanders were invited to participate, and 4 agreed. Students of the participating schools completed the paper questionnaire that was distributed during class time, and returned it in a closed envelope. Through secondary schools, 276 women were recruited. Thirdly, a social worker at a youth welfare organization informed young women about the study. Those who were interested in participating completed the paper questionnaire and returned it in a closed envelope. Eight women were recruited through this organization. Fourthly, the manager of a private company informed women about the study and invited them to complete the questionnaire. Women could take a paper questionnaire, fill it in, and then place it in a closed envelope. Two women were recruited through this method. Fifthly, the questionnaire was also available online and was disseminated through social media and websites of public agencies and other organizations. To maximize the response rate, a gift voucher of €50 was raffled off among the participants that completed the online questionnaire. In total, 1546 women were recruited via social media and websites.

Data analysis

Questionnaires with more than 25% missing values were excluded from the analysis. Data were analyzed using SPSS version 21 (IBM Corporation, Armonk, NY, USA). Descriptive analyses were conducted on all data using frequencies (percentages) for categorical variables, and means (standard deviation) or median (range) for continuous variables. Each of the nine preconception behavioral intentions were analyzed separately. Simple logistic regression analyses were performed to explore significant socio-demographic and psychosocial factors associated with the intention to make a preconception lifestyle change. Independent variables with $p \leq 0.10$ were included in the multiple logistic regression analysis. Additionally, an overall intention score was computed by averaging the scores on the intention items. Because the overall intention score was not normally distributed, nonparametric tests were used. Spearman's rho correlations were computed to explore associations between psychosocial factors and behavioral intention. Simple linear regression analysis with bootstrapping methods (10 000 bootstrapping samples) was used to study the association between the overall intention score and each psychosocial factor or socio-demographic variable. Independent variables with $p \leq 0.10$ were included in the multiple linear regression analysis with bootstrapping methods (6 000

bootstrapping samples). The 'enter' regression method was used for all logistic and linear regression analyses. Prior to the multiple regression analyses, data were screened for multicollinearity using tolerance values and variance inflation factor (VIF). All variables had a tolerance level higher than 0.4, indicating no multicollinearity problems. The items on income and perceived poverty, folic acid use in a previous pregnancy, and fertility treatment were sub-questions that were skipped if they were not relevant for the respondent. Because of a high number of missing values, these variables were not entered in the multiple model. The significance level was set at a value of $p < 0.05$.

RESULTS

Characteristics of the respondents

The questionnaire was completed by 1922 women, of whom 9 did not meet the age criteria, 194 had no desire for (more) children, and 3 had more than 25% missing answers. After excluding these 200 from data-analyses, the final sample consisted of 1722 respondents. The mean age was 24.9 years (± 5.7). Sixty-three percent were educated at bachelor's or master's level. The majority of women were natives (86%), in a relationship (78%), and had no biological children (76%). One in three women (31%) had a desire for children within one year (Table 1).

Table 1. Characteristics of the respondents (n= 1722)

Variable	Mean (SD)	Median (range)
Age (years)	24.9 (5.7)	25.0 (15 – 45)
BMI (kg/m²)	22.8 (3.9)	22.0 (13.7 – 43.0)
Variable	**n**	**%**
Ethnicity		
Immigrants[a]	237	14.4
Natives	1428	85.6
Partnership status		
Relationship	1331	78.4
No relationship	366	21.6
Education[b]		
Low	629	36.7
High	1087	63.3
Paid employment[c]		
Yes	965	94.2
No	59	5.8
Net household income[c]		
< €2.000	225	22.2
€2.000 - €2.999	198	19.5
> €3.000	591	58.3

Variable	n	%
Perceived poverty: making ends meet…[c,d]		
Easy	916	90.2
Difficult	100	9.8
Biological children		
Yes	410	24.0
No	1296	76.0
History of fertility treatment[e]		
Yes	63	15.3
No	350	84.7
Folic acid use in previous pregnancy[e]		
Yes	328	79.6
No	84	20.4
Preconception consult before previous pregnancy?[e]		
Yes	254	61.8
No	157	38.2
Desire for children		
Within one year	531	31.1
Longer than one year	1174	68.9
Smoking		
Yes	155	9.0
No	1559	91.0
Alcohol use		
Yes	1075	62.6
No	641	37.4
Serious medical condition		
Yes	128	7.5
No	1580	92.5
Long-term medication use		
Yes	302	17.6
No	1410	82.4

[a]One or both of the parents born outside Belgium; [b]Low level of education: primary, secondary or post-secondary education versus high level of education: college or university education; [c]Only questioned in non-student population (n=1024); [d]Perceived poverty was measured by asking "how easy or difficult is it to make ends meet?"; [e]Only questioned in women who reported having biological children; Abbreviations, BMI, Body Mass Index; SD: standard deviation.

Psychosocial factors

Overall, women had a high overall attitude (median score: 25.0 on the 6–33 scale) and high self-efficacy (median score: 1.0 on the 0–1 scale) score indicating they had positive attitudes and high self-efficacy regarding preparing for pregnancy. Women were most sensitive for influences from the close social environment and healthcare providers, with a median score of 17.0 on the 4–24 scale and 5.0 on the 1–6 scale, respectively. The opinion of the (future) partner and healthcare providers were rated as most important with a

median score of 6.0 and 6.0 on the 1–6 scale, respectively. The total knowledge score was moderate with a median score of 11.0 on the scale 0–17. The knowledge about tobacco, alcohol, and substance abuse was high with 81% to 87% correct answers. By contrast, the knowledge about folic acid intake (33%–63% correct answers), preventive steps for foodborne infections (toxoplasmosis, 44% correct answers; listeriosis, 33% correct answers), and vaccination (37% correct answers) was low. Overall, women reported few barriers regarding preconception lifestyle changes. The most reported barrier was lack of perceived need for preconception lifestyle changes with a median score of 4.0 on the 1–6 scale (Table 2).

Table 2. Spearman's rho correlations and descriptive variables for psychosocial factors (n= 1722)

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Intention		0.36**	0.46**	0.19**	0.18**	0.04	0.13**	0.26**	-0.22**	-0.21**	-0.02	-0.16**	-0.16**
2. Attitude			0.18**	0.34**	0.37**	0.002	0.18**	0.30**	-0.33**	-0.29**	-0.16**	-0.30**	-0.18**
3. Self-efficacy (overall score)				0.07**	0.10**	0.04	0.04	0.28**	-0.21**	-0.05*	-0.11**	-0.10**	-0.07**
4. Social influence close social environment					0.54**	0.19**	0.25**	0.02	-0.04	-0.08**	-0.003	-0.06**	-0.09**
5. Social influence healthcare providers						0.13**	0.19**	0.12**	-0.14**	-0.10**	-0.08**	-0.15**	-0.12**
6. Social influence media							0.09**	-0.005	0.10**	0.23**	0.07**	0.07**	-0.03
7. Importance of others' opinion								0.04	-0.03	-0.06*	-0.02	-0.08**	-0.07**
8. Knowledge									-0.48**	-0.14**	-0.16**	-0.24**	-0.04
9. Barrier: health literacy										0.40**	0.28**	0.45**	-0.03
10. Barrier: emotions and beliefs											0.14**	0.25**	0.02
11. Barrier: religion												0.29**	-0.08**
12. Barrier: financial													-0.005
13. Barrier: perceived need													
Mean (SD)	0.84 (0.18)	25.31 (3.51)	0.93 (0.13)	16.56 (3.35)	4.69 (0.93)	2.95 (1.25)	23.79 (3.05)	10.77 (3.10)	11.65 (4.66)	15.30 (4.21)	1.35 (0.81)	1.84 (1.05)	3.98 (1.12)
Median (Range)	0.83 (0 – 1)	25.00 (14 – 33)	1.00 (0 – 1)	17.00 (4 – 24)	5.00 (1 – 6)	3.00 (1 – 6)	24.00 (5 – 30)	11.00 (0 – 17)	11.00 (5 – 30)	15.00 (5 – 30)	1.00 (1 – 6)	2.00 (1 – 6)	4.00 (1 – 6)

* correlation is significant at 0.05 level; ** correlation is significant at 0.01 level

Socio-demographic and psychosocial factors associated with the intention for specific preconception lifestyle changes

Intention to live a healthy life

Overall, most women had the intention to live a healthy life in the preconception period (n= 1635, 96%). The results of the multiple logistic regression analysis showed that having a positive attitude (odds ratio [OR] 1.33, 95% confidence interval [CI] 1.19–1.48) and higher self-efficacy to live a healthy life (OR 108.64, 95%CI 31.78–371.42) increased the likelihood of intending to live a healthy life. Experiencing negative emotions and beliefs regarding preparing for pregnancy (OR 0.92, 95%CI 0.85–0.99) and having biological children (OR 0.36, 95%CI 0.16–0.83) decreased the odds of intending to life a healthy life in the preconception period. This model explained 30.0% of the variance of the intention to live a healthy (Table 3).

Table 3. Summary of multiple logistic regression analysis[a] for socio-demographic and psychosocial factors associated with individual preconception behavioral intentions.

Variable	*B*	SE	p-value	OR	95% CI
Intention to live a healthy life (n= 1562)					
Attitude	0.28	0.06	<0.001	1.33	1.19 – 1.48
Self-efficacy to live a healthy life	4.69	0.63	<0.001	108.64	31.78 – 371.42
Social influence close social environment	0.04	0.06	0.51	1.04	0.93 – 1.17
Social influence healthcare providers	0.06	0.20	0.78	1.06	0.72 – 1.56
Importance of others' opinion	0.04	0.05	0.48	1.04	0.94 – 1.15
Knowledge	-0.06	0.06	0.33	0.94	0.83 – 1.06
Barrier: health literacy	0.04	0.05	0.38	1.04	0.95 – 1.14
Barrier: emotions and beliefs	-0.08	0.04	0.046	0.92	0.85 – 0.99
Barrier: financial	-0.07	0.16	0.69	0.94	0.68 – 1.28
Barrier: perceived need	0.06	0.16	0.69	1.07	0.78 – 1.45
Age	0.01	0.04	0.83	1.01	0.93 – 1.10
Education: high	0.65	0.42	0.12	1.92	0.84 – 4.41
Ethnicity: natives	0.29	0.44	0.49	1.35	0.57 – 3.17
Biological children: yes	-1.01	0.42	0.02	0.36	0.16 – 0.83
Desire for children: within one year	-0.14	0.37	0.71	0.87	0.42 – 1.81
Smoking: yes	-0.12	0.54	0.82	0.88	0.31 – 2.56
Intention to take folic acid daily (n= 1527)					
Attitude	0.07	0.03	0.009	1.08	1.02 – 1.14
Self-efficacy to take folic acid daily	3.23	0.31	<0.001	25.29	13.73 – 46.57
Social influence close social environment	0.02	0.03	0.48	1.02	0.96 – 1.09
Social influence healthcare providers	0.15	0.11	0.18	1.16	0.94 – 1.43
Importance of others' opinion	0.03	0.03	0.23	1.04	0.98 – 1.10
Knowledge about folic acid	0.74	0.21	<0.001	2.10	1.40 – 3.16
Barrier: health literacy	-0.12	0.02	<0.001	0.89	0.85 – 0.93

Variable	*B*	SE	p-value	OR	95% CI
Barrier: emotions and beliefs	-0.01	0.02	0.81	0.99	0.95 – 1.04
Barrier: religion	0.26	0.19	0.03	1.30	1.03 – 1.64
Barrier: financial	-0.23	0.09	0.009	0.80	0.67 – 0.94
Barrier: perceived need	-0.17	0.08	0.04	0.85	0.72 – 0.99
Age: older than 25 years	0.51	0.22	0.02	1.66	1.08 – 2.54
Education: high	0.33	0.20	0.10	1.39	0.94 – 2.05
Net household income[b]	/	/	/	/	/
Perceived poverty: making ends meet…[b]	/	/	/	/	/
Ethnicity: natives	0.28	0.24	0.24	1.33	0.83 – 2.13
Relationship: yes	0.10	0.20	0.62	1.10	0.74 – 1.64
Biological children: yes	-0.12	0.25	0.65	0.89	0.55 – 1.46
History of fertility treatment[b]	/	/	/	/	/
Folic acid use in previous pregnancy[b]	/	/	/	/	/
Desire for children: within one year	0.79	0.22	<0.001	2.20	1.42 – 3.40
Alcohol: yes	-0.16	0.19	0.39	0.85	0.59 – 1.23
Smoking: yes	-0.37	0.30	0.23	0.69	0.38 – 1.25
BMI: overweight/obesity	0.05	0.20	0.80	1.05	0.71 – 1.57
Intention to eat healthy (n= 1570)					
Attitude	0.13	0.05	0.006	1.13	1.04 – 1.24
Self-efficacy to eat healthy	4.00	0.53	<0.001	54.24	19.28 – 152.57
Social influence close social environment	0.05	0.05	0.26	1.06	0.96 – 1.16
Knowledge	-0.09	0.06	0.12	0.92	0.82 – 1.02
Barrier: health literacy	-0.02	0.04	0.60	0.98	0.91 – 1.05
Barrier: religion	0.06	0.19	0.75	1.06	0.73 – 1.56
Barrier: financial	-0.18	0.14	0.21	0.84	0.63 – 1.11
Age: older than 25 years	0.17	0.36	0.64	1.18	0.58 – 2.39
Education: high	0.37	0.38	0.33	1.45	0.69 – 3.07
Ethnicity: natives	0.06	0.42	0.89	1.06	0.47 – 2.39
Relationship: yes	-0.07	0.36	0.85	0.93	0.46 – 1.91
Smoking: yes	-0.03	0.49	0.95	0.97	0.37 – 2.52
Intention to take steps to prevent foodborne illness (n= 1567)					
Attitude	0.13	0.02	<0.001	1.14	1.09 – 1.19
Self-efficacy to take preventive steps	2.77	0.24	<0.001	15.90	9.98 – 25.31
Social influence close social environment	0.04	0.03	0.09	1.04	0.99 – 1.10
Social influence healthcare providers	-0.10	0.09	0.28	0.91	0.76 – 1.08
Importance of others' opinion	0.05	0.02	0.04	1.05	1.00 – 1.10
Knowledge about preventive steps	0.56	0.14	<0.001	1.75	1.34 – 2.29
Barrier: emotions and beliefs	-0.09	0.02	<0.001	0.91	0.88 – 0.95
Barrier: religion	0.29	0.11	0.01	1.33	1.07 – 1.65
Barrier: perceived need	-0.07	0.07	0.27	0.93	0.82 – 1.06
Age: older than 25 years	-0.30	0.19	0.12	0.74	0.51 – 1.08
Education: high	-0.35	0.19	0.07	0.71	0.48 – 1.03

Variable	*B*	SE	p-value	OR	95% CI
Ethnicity: natives	-0.23	0.23	0.32	0.80	0.51 – 1.24
Relationship: yes	-0.15	0.20	0.44	0.86	0.58 – 1.27
Biological children: yes	-0.40	0.17	0.02	0.67	0.49 – 0.93
History of fertility treatment[b]	/	/	/	/	/
Desire for children: within one year	-0.19	0.16	0.24	0.83	0.61 – 1.13
Smoking: yes	0.23	0.28	0.41	1.26	0.73 – 2.19
Intention to search for information and advice on how to become pregnant in a healthy way (n= 1606)					
Attitude	0.14	0.03	<0.001	1.15	1.09 – 1.21
Self-efficacy to search information/advice	4.26	0.65	<0.001	70.46	19.70 – 252.02
Social influence close social environment	0.05	0.03	0.11	1.05	0.99 – 1.12
Social influence healthcare providers	0.21	0.11	0.06	1.23	1.00 – 1.53
Social influence media	0.04	0.07	0.64	1.04	0.90 – 1.20
Importance of others' opinion	0.05	0.03	0.08	1.05	0.99 – 1.11
Barrier: emotions and beliefs	-0.06	0.02	0.006	0.94	0.90 – 0.98
Barrier: financial	0.03	0.09	0.75	1.03	0.87 – 1.22
Barrier: perceived need	-0.18	0.09	0.04	0.83	0.70 – 0.99
Biological children: yes	-0.89	0.18	<0.001	0.41	0.29 – 0.59
Folic acid use in previous pregnancy[b]	/	/	/	/	/
Intention to stop smoking (n= 115)					
Attitude	0.15	0.12	0.21	1.16	0.92 – 1.47
Self-efficacy to stop smoking	4.34	1.19	<0.001	76.78	7.43 – 793.87
Social influence close social environment	-0.04	0.12	0.78	0.97	0.76 – 1.23
Social influence healthcare providers	0.25	0.39	0.53	1.28	0.59 – 2.75
Importance of others' opinion	0.16	0.11	0.14	1.17	0.95 – 1.45
Barrier: emotions and beliefs	-0.17	0.09	0.046	0.84	0.71 – 0.99
Barrier: perceived need	0.05	0.32	0.87	1.05	0.57 – 1.96
Relationship: yes	-1.22	0.91	0.18	0.30	0.05 – 1.77
Biological children: yes	-1.12	0.78	0.15	0.33	0.07 – 1.51
Desire for children: within one year	-1.61	0.80	0.04	0.20	0.04 – 0.96
Alcohol: yes	0.37	0.73	0.62	1.44	0.34 – 6.07
Intention to stop drinking alcohol if you could be pregnant (n= 1022)					
Attitude	0.06	0.04	0.15	1.06	0.98 – 1.14
Self-efficacy to stop drinking alcohol	4.59	0.43	<0.001	98.26	41.97 – 230.33
Knowledge about alcohol	0.82	0.30	0.005	2.28	1.28 – 4.06
Barrier: perceived need	0.01	0.12	0.92	1.01	0.80 – 1.28
Education: high	-0.12	0.29	0.68	0.89	0.50 – 1.57
Biological children: yes	-1.06	0.31	0.001	0.35	0.19 – 0.64
Desire for children: within one year	0.11	0.30	0.73	1.11	0.62 – 2.00
Intention to lose weight (n= 341)					
Attitude	0.12	0.05	0.02	1.12	1.02 – 1.23
Self-efficacy to lose weight	3.53	0.50	<0.001	34.07	12.75 – 91.02
Knowledge about weight	0.10	0.38	0.78	1.11	0.53 – 2.32

Variable	*B*	SE	p-value	OR	95% CI
Barrier: emotions and beliefs	-0.04	0.03	0.29	0.97	0.91 – 1.03
Barrier: perceived need	-0.68	0.14	<0.001	0.51	0.38 – 0.67
Age	0.003	0.03	0.93	1.00	0.94 – 1.07
Education: high	-0.54	0.36	0.13	0.59	0.29 – 1.18
Net household income[b]	/	/	/	/	/
Desire for children: within one year	0.27	0.31	0.38	1.30	0.72 – 2.37
Alcohol: yes	-0.40	0.29	0.18	0.67	0.38 – 1.19
Smoking: yes	-1.17	0.50	0.02	0.31	0.12 – 0.83
Intention to discuss medication/herb use with healthcare provider (n= 289)					
Attitude	0.07	0.05	0.19	1.07	0.97 – 1.18
Self-efficacy to discuss medication/herb use	4.52	0.76	<0.001	91.83	20.58 – 409.78

[a]All variables with a p-value of ≤ 0.10 in the simple regression analysis were included; [b]Not included in the multiple regression model due to missing data. Abbreviations, *B*: Beta; BMI, Body Mass Index; CI, Confidence Interval; SE, standard error; OR, Odds Ratio.

Intention to take folic acid daily

Overall, 1213 (72%) women had the intention to take folic acid on a daily basis preconceptionally. The findings of the multiple logistic regression analysis revealed that having a positive attitude (OR 1.08, 95% CI 1.02–1.14), higher self-efficacy to take folic acid daily (OR 25.29, 95%CI 13.73–46.57), and higher knowledge on folic acid (OR 2.10, 95% CI 1.40–3.16) increased the odds of intending to take folic acid daily. Poor health literacy (OR 0.89, 95% CI 0.85–0.93), financial barriers (OR 0.80, 95% CI 0.67–0.94), and lack of perceived need for preconception lifestyle changes (OR 0.85, 95% CI 0.72–0.99) decreased the likelihood of intending to take folic acid. Surprisingly, religion as a barrier to prepare for pregnancy increased the likelihood of intending to take folic acid (OR 1.30, 95% CI, 1.03–1.64). In addition, a desire for children within one year (OR 2.20, 95% CI, 1.42–3.40) and being older than 25 years old (OR 1.66, 95% CI 1.08–2.54) was positively associated with the intention to take folic acid on a daily basis in the preconception period. This model explained 52% of the variance of the intention to take folic acid daily (Table 3).

Intention to eat healthy

The majority (n= 1618, 95%) of the women had the intention to eat healthy in the preconception period. The results of the multiple logistic regression analysis showed that having a positive attitude (OR 1.13, 95% CI 1.04–1.24) and higher self-efficacy to eat healthy (OR 54.24, 95%CI 19.28–152.58) increased the odds of intending to eat healthy. This model explained 19% of the variance of the intention to eat healthy in the preconception period (Nagelkerke R^2= 0.19)(Table 4).

Intention to take steps to prevent foodborne illness

In total, 1225 (72%) women had the intention to take steps to prevent foodborne infections in the preconception period. Having a positive attitude (OR 1.14, 95% CI 1.09–1.19), higher self-efficacy to take steps to

prevent foodborne illness (OR 15.90, 95%CI 9.98–25.31), perceiving the opinion of others about preconception lifestyle changes as more important (OR 1.05, 95% CI 1.00–1.10), and higher knowledge about prevention of foodborne diseases (OR 1.75, 95% CI 1.34 – 2.29) increased the odds of intending to take steps to prevent foodborne infections. Experiencing negative emotions and beliefs about preparing for pregnancy (OR 0.91, 95% CI 0.88–0.95) and having biological children (OR 0.67, 95% CI 0.49 – 0.93) were negatively associated with the intention to take preventive steps. Unexpectedly, religion as a barrier to prepare for pregnancy (OR 1.33, 95% CI 1.07 – 1.65) was positively associated with the intention to take steps to prevent foodborne diseases. This model explained 34% of the variance of the intention to take steps to prevent foodborne illness in the preconception period (Nagelkerke R^2= 0.34)(Table 3).

Intention to search for information or advice on how to become pregnant in a healthy way

The majority (n= 1485, 87%) of the women intended to search information or advice on how to become pregnant in a healthy way. The results of the multiple logistic regression analysis showed that having a positive attitude (OR 1.15, 95% CI 1.09–1.21) and higher self-efficacy to search for information or advice (OR 70.46, 95%CI 19.70–252.02) increased the odds of intending to search for information or advice. Experiencing negative emotions and beliefs regarding preparing for pregnancy (OR 0.94, 95%CI 0.90–0.98), lack of perceived need for preconception lifestyle changes (OR 0.83, 95% CI 0.70–0.99), and having biological children (OR 0.41, 95%CI 0.29–0.59) decreased the odds of intending to search for information or advice. This model explained 26% of the variance of the intention to search for information or advice on how to become pregnant in a healthy way (Nagelkerke R^2= 0.26)(Table 3).

Intention to stop smoking

Nine percent of the women smoked (n= 155). Most of these women (n= 120, 80%) had the intention to stop smoking in the preconception period. Higher self-efficacy to stop smoking (OR 76.78, 95% CI 7.43–793.87) increased the likelihood of intending to stop smoking preconceptionally. Experiencing negative emotions and beliefs regarding preparing for pregnancy (OR 0.84, 95% CI 0.71–0.99) and wanting to become pregnant within one year (OR 0.20, 95% CI 0.04–0.96) decreased the odds of intending to stop smoking. This model explained 57% of the variance of the intention to stop smoking (Nagelkerke R^2= 0.57)(Table 3).

Intention to stop drinking alcohol if you could be pregnant

In total, 63% (n= 1075) of the women consumed alcohol. Most of these women (n= 950, 89%) had the intention to stop drinking alcohol if they could be pregnant. Higher self-efficacy to consume alcohol (OR 98.26, 95% CI 41.97–230.03) and higher knowledge about alcohol (OR 2.28, 95% CI 1.28–4.06) increased the likelihood of intending to stop drinking alcohol when they might be pregnant. Having biological children (OR 0.35, 95% CI

0.19–0.64) was negatively associated with the intention to stop drinking alcohol preconceptionally. This model explained 36% of the variance of the intention to stop consuming alcohol in the preconception period (Nagelkerke R^2= 0.36)(Table 3).

Intention to lose weight

Almost one in four women were overweight or obese (n= 359, 22%), of whom less than half intended to lose weight before becoming pregnant (n= 165, 47%). The results of the multiple logistic regression analysis indicated that having a positive attitude (OR 1.12, 95% CI 1.02–1.23) and higher self-efficacy to lose weight (OR 34.07, 95%CI 12.75–91.02) increased the odds of intending to lose weight. Lack of perceived need for preconception lifestyle changes (OR 0.51, 95% CI 0.38–0.67) was negatively associated with the intention to lose weight preconceptionally. In addition, smoking (OR 0.31, 95% CI 0.12 – 0.83) decreased the likelihood of intending to lose weight in the preconception period. This model explained 48% of the variance of the intention to lose weight in the preconception period (Nagelkerke R^2= 0.48)(Table 3).

Intention to discuss medication or herb use with a healthcare provider

Approximately one in five women (n= 302, 18%) reported long-term medication use, of whom 81% (n= 242) intended to discuss medication or herb use with a healthcare provider. Self-efficacy to discuss medication use (OR 91.83, 95%CI 20.58–409.78) was the only positively associated factor with the intention to discuss medication or herb use with a healthcare provider. This model explained 40% of the variance of the intention to lose weight in the preconception period (Nagelkerke R^2= 0.40)(Table 3).

Socio-demographic and psychosocial factors associated with the overall intention to prepare for pregnancy

Overall, there was a high overall intention to prepare for pregnancy with a median score of 0.83 on the 0–1 scale (Table 2). Self-efficacy (r_s = 0.46, $p < 0.001$), attitude (r_s = 0.36, $p < 0.001$), and knowledge (r_s = 0.26, $p < 0.001$) had the highest correlations with the intention to prepare for pregnancy. In addition, the results showed that poor healthy literacy (r_s = -0.22, $p < 0.001$) and negative emotions and beliefs about preparing for pregnancy (r_s = -0.21, $p < 0.001$) were the strongest barriers associated with the intention to prepare for pregnancy. The social influence of the media and religion as barrier to prepare for pregnancy were the only factors that were not significantly associated with the intention score. The results of the multiple linear regression analysis revealed that a positive attitude (beta [B] = 0.10, standard error [SE] = 0.001, $p < 0.001$), higher self-efficacy (B = 0.50, SE = 0.04, $p < 0.001$), higher knowledge scores (B = 0.004, SE = 0.002, $p = 0.01$) were positively associated with a higher overall intention score. The experience of barriers to prepare for pregnancy, including negative emotions and beliefs about preparing for pregnancy (B = -0.005, SE = 0.001, p <

0.001) and lack of perceived need for preconception lifestyle changes (B = -0.008, SE = 0.004, p = 0.03), was associated with less intention to prepare for pregnancy. Surprisingly, religion as a barrier to prepare for pregnancy was associated with a higher intentional score (B = 0.02, SE = 0.007, p = 0.01). Nulliparity (B = 0.05, SE = 0.01, p < 0.001) and a normal weight (B = 0.03, SE = 0.01, p < 0.001) were positively associated with a higher intention score to prepare for pregnancy. This model explained 30.0% of the variance of the intention to prepare for pregnancy (adjusted R^2 29.1%)(Table 4).

Table 4. Summary of multiple linear regression analysis[a] with bootstrapping methods (10 000 bootstrapping samples) for socio-demographic and psychosocial factors associated with the overall intention to prepare for pregnancy (n= 1528)

Variable	*B*	SE	p-value	95% CI
Attitude	0.10	0.001	<0.001	0.007 – 0.01
Self-efficacy (overall score)	0.50	0.04	<0.001	0.43 – 0.58
Social influence close social environment	0.003	0.001	0.06	0.00007 – 0.005
Social influence healthcare providers	0.003	0.01	0.53	-0.007 – 0.01
Importance of others' opinion	0.002	0.001	0.13	-0.001 – 0.005
Knowledge	0.004	0.002	0.01	0.001 – 0.007
Barrier: health literacy	-0.001	0.001	0.49	-0.003 – 0.001
Barrier: emotions and beliefs	-0.005	0.001	<0.001	-0.007 – -0.003
Barrier: religion	0.02	0.01	0.01	0.003 – 0.03
Barrier: financial	-0.007	0.01	0.14	-0.02 – 0.003
Barrier: perceived need	-0.008	0.004	0.03	-0.02 – -0.001
Age	-0.001	0.001	0.60	-0.003 – 0.002
Education: low	-0.01	0.01	0.39	-0.03 – 0.01
Ethnicity: immigrants	-0.01	0.01	0.43	-0.03 – 0.01
Relationship: no	0.002	0.01	0.88	-0.02 – 0.02
Biological children: no	0.05	0.01	<0.001	0.03 – 0.07
History of fertility treatment[b]	/	/	/	/
Folic acid use in previous pregnancy[b]	/	/	/	/
Desire for children: longer than 1 year	-0.02	0.01	0.07	-0.04 – 0.001
Smoking: no	0.008	0.02	0.57	-0.02 – 0.04
BMI: no overweight/obesity	0.03	0.01	<0.001	0.01 – 0.05

[a]All variables with a p-value of ≤ 0.10 in the simple regression analysis were included; [b]Not included in the multiple regression model due to missing data. Abbreviations, *B*: Beta; BMI, Body Mass Index; CI, Confidence Interval; SE, standard error.

DISCUSSION

The purpose of this study was to identify socio-demographic and psychosocial factors associated with the overall intention to prepare for pregnancy and different preconception lifestyle changes in the general population of reproductive-aged women, with the Attitude – Social influence – Self-efficacy (ASE) model as theoretical basis (de Vries et al., 1988; De Vries et al., 1998).

Overall intention to prepare for pregnancy

In general, the overall intention to prepare for pregnancy was high with an overall median score of 0.84 on a 0–1 scale. Self-efficacy and attitude were the strongest factors associated with the overall intention to prepare for pregnancy. In a study of Temel et al. (2013), self-efficacy was no predictor for the intention to visit a preconception care consult. Other studies have found a clear relationship between self-efficacy and lifestyle changes such as smoking cessation (Devries and Backbier, 1994) and fruit and vegetable consumption (Brug et al., 1995). Consulting a healthcare provider is a one-off event which is much easier to achieve compared to ongoing or habitual behavior changes as smoking cessation or changing eating habits, and may explain why other factors than self-efficacy were found to predict the intention to use preconception care in the study of Temel et al. (2013). In addition, our results showed that a positive attitude towards preconception lifestyle changes was associated with higher overall intention to prepare for pregnancy, which is in line with previous studies investigating the role of attitude in the use of preconception care (Mazza and Chapman, 2010; Temel et al., 2013). Social influence, which is a third important predictor of behavioral intention in the ASE model, did not remain significant in the final model. These results are in line with the findings of Temel et al. (2013), but are contrary to findings of Janz et al. (1995). Several qualitative studies, including the study of van der Zee et al. (2013), have shown that many women prefer to keep their plans to become pregnant a secret because they do not want other people to intermeddle with or inquire about it, or to avoid expectations which they cannot fulfill. This wish for secrecy may explain why social influence was no significant correlate of intention to prepare for pregnancy.

Furthermore, knowledge was another associated factor of the overall intention to prepare for pregnancy, which is in line with previous studies (Charron-Prochownik et al., 2013). However, several other studies found no association between preconception knowledge and (intention for) preconception health behavior (Harelick et al., 2011; Temel et al., 2013). Preconception interventions typically focus on knowledge improvement (Toivonen et al., 2017). Although our findings support the importance of preconception knowledge, it was not the only and not the strongest associated factor of the intention to prepare for pregnancy. Therefore, it is recommended to develop interventions that focus on different psychosocial factors and not solely on knowledge. Consistent with the findings of Frey and Files (2006) and Harelick et al. (2011), the highest knowledge scores were on items about tobacco, alcohol, and substance abuse, and the lowest scores on folic acid intake and preventive steps for foodborne infections.

We also found a relationship between experiencing barriers and the overall intention to prepare for pregnancy. Women experiencing more negative emotions and beliefs regarding preparing for pregnancy such as stress, the fear of a negative influence on fertility due to being overly concerned about becoming pregnant, believing

preconception health and care is medicalization of conception, and the wish for secrecy decreased the likelihood of intending to prepare for pregnancy. Lack of perceived need for preconception lifestyle changes was another important barrier for the intention to prepare for pregnancy. Both perceived need and emotions and beliefs have been identified as important factors influencing the use of preconception care in a systematic review of Poels et al. (2016). Although there was a significant association between the overall intention to prepare for pregnancy, and poor health literacy ($p<0.001$) and financial barriers ($p<0.001$), these factors did not remain significant in the final regression model. Instead, religion as a barrier to prepare for pregnancy, which was one of the only non-significant factors in the correlation analysis ($p=0.53$) and simple linear regression analysis ($p=0.07$), became a significant associated factor in the final model. It is possible that there was an interaction between these three barriers as these factors were significantly associated with each other in the correlation analysis, resulting in one significant factor. Surprisingly, religion as a barrier to prepare for pregnancy increased the likelihood of intending to prepare for pregnancy, and thus, was actually a facilitator rather than a barrier.

Intention for specific preconception health behaviors

The highest intention scores were for living a healthy life (96%), eating healthy (95%), and stop drinking alcohol if they could be pregnant (89%). The lowest intention scores were for losing weight (47%), and discussing medication or herb use with a healthcare provider (18%). These results differ from previous studies on preconception lifestyle changes, which showed that folic acid intake was the most common lifestyle change prior to pregnancy, while alcohol cessation and improvement of diet were the least reported preconception health behaviors (Poels et al., 2017; Goossens et al., 2018). However, the results regarding the intention to lose weight in overweight or obese women were in line with those of Goossens et al. (2018), who found only 18% of the obese or overweight women reported to achieve a healthier weight in the preconception period.

Overall, the psychosocial factors associated with intention for a specific preconception lifestyle were similar to those predicting the overall intention to prepare for pregnancy, which is logical since the overall intention score was computed by averaging the scores on the different intention items. However, certain preconception behavioral intentions were more difficult to explain with the model that was used, for example the intention to eat healthy and to search information or advice on how to become pregnant in a healthy way, which reflected in a lower explained variance (Nagelkerke R^2= 0.19 and 0.26, respectively). The small amount of explained variance suggests that other factors beyond the psychosocial factors might be involved in the intention to prepare for pregnancy. The ASE model and other social-cognitive models are based on the assumption that behavior is the result of conscious choices or rational decisions that individuals make (Sniehotta et al., 2014). It is possible that routine habits and unconscious influences are also associated with

the intention to prepare for pregnancy, which is not captured by the ASE model (Deutsch and Strack, 2006; Hoffman et al., 2008; Frankish, 2010; Sniehotta et al., 2014).

Parity was the most important socio-demographic factor associated with the overall intention to prepare for pregnancy and of the different preconception behavioral intentions. Women having biological children were less inclined to prepare for pregnancy. These results are in line with previous findings (Poels et al., 2016; Poels et al., 2017; Goossens et al., 2018), and can be explained by the fact that women with biological children have a more relaxed attitude towards preconception health and lifestyle changes. It would be interesting to further explore this hypothesis through a qualitative study.

Methodological considerations

This study has several strengths worth mentioning. This study was one of the first studies that identified psychosocial factors associated with the overall intention to prepare for pregnancy and different preconception lifestyle changes in the general population of reproductive-aged women. Other strengths include its large sample size (n= 1722), recruitment from multiple sites, and the use of a validated questionnaire. Nevertheless, this study has a number of limitations that affect the interpretation of the findings. First, the pre-test included 11 native women of whom 6 were higher educated. As a result, it is possible that some words, items of expression were less readable or too difficult to read and understand to women of lower socio-economic status. Second, with the exception of students recruited from secondary schools, the sample was self-selected leading to self-selection bias. Third, only women with an understanding of written Dutch or English were included in the study, increasing the risk of selection bias. Selection bias can lead to a sample which is not representative of the study population. Based on education, income, and paid employment, we can conclude that women of higher socio-economic status (SES) were overrepresented in our study. Therefore, the actual intention to prepare for pregnancy and associated factors may be different because preconception lifestyle changes are associated with higher SES as reported in other research (Stephenson et al., 2014; Joelsson et al., 2016; Toivonen et al., 2017; Goossens et al., 2018). Fourth, this study was focused on the intention to make preconception lifestyle changes, as opposed to the behavior itself. It would be interesting to conduct a longitudinal study assessing the ASE constructs at one point, for example in women who plan to become pregnant between 6 months and 1 year, and the preconception lifestyle changes at the time they are trying to conceive. By assessing intention before behavior, this could also provide insight into the causality of the association between preconception behavior and the factors. The cross-sectional design of the present study does not permit any conclusions about causality, which is a fifth limitation of our study. Sixth, the intention was only assessed towards certain preconception lifestyle changes and behaviors.

Future research should investigate other preconception lifestyle changes and behavior, including immunization, sexual transmitted infection screening, and minimizing exposure to environmental toxins. Seventh, intention and self-efficacy were assessed and analyzed as dichotomous single-items, which is in all probability an oversimplification of complex psychosocial constructs. In addition, high odds ratios and broad confidence intervals were observed for the independent variable self-efficacy, which can be the result of low cell frequencies in some of the categories. Low cell frequencies were frequently observed in the subgroup of women with a low self-efficacy and a positive intention. As a result, the actual strength of the association between intention and self-efficacy is uncertain, and therefore, need to be interpreted with caution. Furthermore, preparing for pregnancy was considered as an overarching construct capturing different preconception lifestyle changes and behaviors. An overall intention and self-efficacy score was calculated, which must be interpreted with caution because in general, the intention and self-efficacy regarding a particular behavior cannot be generalized to overarching behavior. Lastly, the variables income, perceived poverty, history of fertility treatment, and use of folic acid in a previous pregnancy were not entered in the multiple regression model due to missing values.

CONCLUSION

Several psychosocial factors were found to be associated women's intention to prepare for pregnancy, including the attitude, self-efficacy, knowledge, negative emotions and beliefs, and lack of perceived need. Parity was the most important socio-demographic factor associated with the intention to prepare for pregnancy. Based on these insights, several recommendations can be made for future intervention development.

It would be interesting to develop a preconception health intervention that focuses on changing the identified factors of preconception behavior (intention), which in turn are supposed to influence preconception behavior (Kok et al., 2016). The Intervention Mapping taxonomy of behavior change methods can be used as a guide to match factors with change methods, and translate them in practical applications (Kok et al., 2016). Verbal persuasion (i.e., the use of messages that suggest a person holds certain capabilities), reinforcement (i.e., linking behavior to a consequence that increases the behavior's degree, frequency or likelihood), and modeling (i.e, the provision of an appropriate model reinforcing the desired behavior) may be different methods to support women's self-efficacy towards preparing for pregnancy (Kok et al., 2016). Verbal persuasion and reinforcement may be translated in a health message that suggests that a woman who wants to become pregnant will do anything to have a healthy baby, and therefore, will make preconception lifestyle changes. One application for modeling could be a role-model-story in a popular television soap opera, for instance, by

creating a storyline about preconception health in which a familiar character or couple wants to become pregnant in healthy manner and learns about preconception lifestyle changes. One method to improve the attitude towards preparing for pregnancy is repeated exposure (i.e., repeating a stimulus to be accessible to an individual's sensory receptors), and could be translated in a sticker on oral contraceptives packages with short preconception health messages (Kok et al., 2016). Methods to increase the knowledge and awareness about preconception health and lifestyle changes include personalize risk (i.e., the provision of information about personal risks of action or inaction regarding the target behavior) and feedback (i.e., the provision of information regarding the extent to which they are accomplishing the performance)(Kok et al., 2016). One translation of personalize risk and feedback could be an online risk assessment questionnaire embedded in a website about preconception health, which provides tailored preconception information and recommendations based on the participants respondents (Kok et al., 2016). Negative emotions and beliefs, and lack of perceived need are related to attitude and awareness, and therefore, could be addressed with the aforementioned methods and practical applications. Further research is needed to explore what are the most appropriate methods and practical applications, which will depend on the context and specific population. Our study population consists of the general population of reproductive-aged women with a desire for (more) children. Methods and practical applications will be different for certain subpopulations such as at-risk groups (e.g. women of lower SES), adolescents, or women already having children.

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REFERENCE LIST

The Collection and Interpretation of Data from Hidden Populations. Edited by: Lambert EY, Wiebel WW. 1990, Washington, DC: United States National Institute on Drug Abuse, from http://www.drugabuse.gov/pdf/monographs/download98.html.

Bartholomew LK, Parcel GS, Kok G, Gottlieb NH, Fernandez ME (2011) Planning health promotion programs: an intervention mapping approach, third Edition: John Wiley & Sons.

Brug J, Lechner L, De Vries H (1995) Psychosocial determinants of fruit and vegetable consumption. Appetite 25:285-296.

Brug J, de Vet E, de Nooijer J, Verplanken B (2006) Predicting fruit consumption: cognitions, intention, and habits. Journal of nutrition education and behavior 38:73-81.

Charron-Prochownik D, Sereika SM, Becker D, White NH, Schmitt P, Powell AB, 3rd, Diaz AM, Jones J, Herman WH, Fischl AF, McEwen L, DiNardo M, Guo F, Downs J (2013) Long-term effects of the booster-enhanced READY-Girls preconception counseling program on intentions and behaviors for family planning in teens with diabetes. Diabetes Care 36:3870-3874.

Deutsch R, Strack F (2006) Duality models in social psychology: From dual processes to interacting systems. Psychological Inquiry 17: 166-172.

de Vries H, Dijkstra M, Kuhlman P (1988) Self-efficacy: the third factor besides attitude and subjective norm as a predictor of behavioural intentions. Health education research 3:273-282.

De Vries H, Mudde AN, Dijkstra A, Willemsen MC (1998) Differential beliefs, perceived social influences, and self-efficacy expectations among smokers in various motivational phases. Prev Med 27:681-689.

Devries H, Backbier E (1994) Self-efficacy as an important determinant of quitting among pregnant women who smoke: The ø-pattern. Preventive medicine 23:167-174.

Frankish K (2010). Dual-process and dual-system theories of reasoning. Philosophy Compass 5: 914-926.

Freimuth VS, Mettger W (1990) Is there a hard-to-reach audience? Public health reports (Washington, DC : 1974) 105:232-238.

Frey KA, Files JA (2006) Preconception healthcare: what women know and believe. Matern Child Health J 10:S73-77.

Goossens J, Beeckman D, Van Hecke A, Delbaere I, Verhaeghe S (2018) Preconception lifestyle changes in women with planned pregnancies. Midwifery 56:112-120.

Harelick L, Viola D, Tahara D (2011) Preconception health of low socioeconomic status women: assessing knowledge and behaviors. Womens Health Issues 21:272-276.

Hofmann W, Friese M., Wiers RW (2008) Impulsive versus reflective influences on health behavior: A theoretical framework and empirical review. Health Psychology Review 2: 111-137.

Hopman-Rock M, Borghouts JA, Leurs MT (2005) Determinants of participation in a health education and exercise program on television. Preventive medicine 41:232-239.

Janz NK, Herman WH, Becker MP, Charron-Prochownik D, Shayna VL, Lesnick TG, Jacober SJ, Fachnie JD, Kruger DF, Sanfield JA, et al. (1995) Diabetes and pregnancy. Factors associated with seeking pre-conception care. Diabetes Care 18:157-165.

Joelsson LS, Berglund A, Wanggren K, Lood M, Rosenblad A, Tyden T (2016) Do subfertile women adjust their habits when trying to conceive? Ups J Med Sci 121:184-191.

Johnson K, Posner SF, Biermann J, Cordero JF, Atrash HK, Parker CS, Boulet S, Curtis MG (2006) Recommendations to improve preconception health and health care--United States. A report of the CDC/ATSDR Preconception Care Work Group and the Select Panel on Preconception Care. MMWR Recomm Rep 55:1-23.

Kok G, Gottlieb NH, Peters GJY, Mullen PD, Parcel GS, Ruiter RA, Fernández ME, Markham C, Bartholomew L (2016) A taxonomy of behaviour change methods: an Intervention Mapping approach. Health Psychology Review 10:297-312.

Korenbrot CC, Steinberg A, Bender C, Newberry S (2002) Preconception care: a systematic review. Matern Child Health J 6:75-88.

Lechner L, Devries H (1995) Starting participation in an employee fitness program: attitudes, social influence, and self-efficacy. Preventive medicine 24:627-633.

Lechner L, De Vries H, Offermans N (1997) Participation in a breast cancer screening program: influence of past behavior and determinants on future screening participation. Preventive medicine 26:473-482.

Lechner L, Oenema A, de Nooijer J (2002) Testicular self-examination (TSE) among Dutch young men aged 15–19: determinants of the intention to practice TSE. Health Education Research 17:73-84.

Mazza D, Chapman A (2010) Improving the uptake of preconception care and periconceptional folate supplementation: what do women think? BMC Public Health 10:786.

Poels M, van Stel HF, Franx A, Koster MPH (2017) Actively preparing for pregnancy is associated with healthier lifestyle of women during the preconception period. Midwifery 50:228-234.

Poels M, Koster MP, Boeije HR, Franx A, van Stel HF (2016) Why Do Women Not Use Preconception Care? A Systematic Review On Barriers And Facilitators. Obstet Gynecol Surv 71:603-612.

Polit DF, Beck CT (2010) Essentials of Nursing Research: Appraising Evidence for Nursing Practice: Wolters Kluwer Health / Lippincott Williams & Wilkins.

Sniehotta FF, Presseau J, Araújo-Soares V (2014) Time to retire the theory of planned behaviour. Taylor & Francis.

Shannon GD, Alberg C, Nacul L, Pashayan N (2013) Preconception health care and congenital disorders: mathematical modelling of the impact of a preconception care programme on congenital disorders. Bjog 120:555-566.

Stephenson J, Patel D, Barrett G, Howden B, Copas A, Ojukwu O, Pandya P, Shawe J (2014) How do women prepare for pregnancy? Preconception experiences of women attending antenatal services and views of health professionals. PLoS One 9:e103085.

Streiner DL, Norman GR, Cairney J (2014) Health measurement scales: a practical guide to their development and use: Oxford University Press, USA.

Temel S, Birnie E, Sonneveld H, Voorham A, Bonsel G, Steegers E, Denktaş S (2013) Determinants of the intention of preconception care use: lessons from a multi-ethnic urban population in the Netherlands. International journal of public health 58:295-304.

Temel S, van Voorst SF, de Jong-Potjer LC, Waelput AJ, Cornel MC, de Weerd SR, Denktas S, Steegers EA (2015) The Dutch national summit on preconception care: a summary of definitions, evidence and recommendations. J Community Genet 6:107-115.

Toivonen KI, Oinonen KA, Duchene KM (2017) Preconception health behaviours: A scoping review. Preventive medicine 96:1-15.

van der Zee B, de Beaufort ID, Steegers EA, Denktas S (2013) Perceptions of preconception counselling among women planning a pregnancy: a qualitative study. Fam Pract 30:341-346.

Supplementary data: "PREPARING FOR PREGNANCY" QUESTIONNAIRE

1. Intention and self-efficacy

1. Living a healthy life.
2. Looking for information or advice on how to become pregnant in a healthy way.
3. Taking folic acid daily.
4. Steps to prevent foodborne illness: thoroughly rinse vegetables/fruits, avoid eating soft cheeses and raw fish, avoid eating homemade foods containing raw eggs…
5. Eating healthy.
6. Stop smoking.
7. Stop drinking alcohol during the period I might be pregnant.
8. Losing weight.
9. Discussing medication or herb use with a health care provider.

2. Attitude

1. I think it is more important to live healthy during a pregnancy than before a pregnancy.
2. I think my chances of having a healthy baby increase as I improve my health prior to a pregnancy
3. I think becoming pregnant is a natural process. It does not require any preparations health-wise.
4. I have little control over the health of my unborn child.
5. I would feel guilty if I did not do everything I could have done to optimize my health before I become pregnant.
6. I think improving my health prior to a pregnancy is…

3. Social influence

3.1 Social influence of close social environment

1. I Think that I am expected to prepare myself for pregnancy.
2. I think that most people in my close social environment (partner, friends, family, colleagues…) would recommend me to prepare myself for pregnancy.
3. I think that most people in my close social environment with a desire to have children, will prepare themselves for pregnancy.
4. I think that most people in my close social environment would support me to prepare myself for pregnancy.

3.2 Social influence of healthcare provider

5. I think that my GP, gynaecologist or medical specialist would recommend me to prepare myself for pregnancy.

3.3 Social influence of media

6. I think that I would feel pressured by the media (TV, newspaper, magazine, radio…) to prepare myself for pregnancy.

3.4 Importance of other's opinion about preconception lifestyle changes

7. How important is the opinion of your (future) partner?
8. How important is the opinion of family?
9. How important is the opinion of friends?
10. How important is the opinion of colleagues or fellow students?
11. How important is the opinion of a GP, gynaecologist or medical specialist?

4. Knowledge

1. Smoking 5 cigarettes a day does not have an influence on a woman's fertility.
2. Smoking 5 cigarettes a day does not have an influence on a man's fertility.
3. Quitting alcohol is only needed after a positive pregnancy test.
4. Overweight women have an equal chance of becoming pregnant as women with a normal weight.
5. The age at which a woman becomes pregnant does not have an influence on the unborn child's health
6. All over-the-counter drugs are safe and can be taken by a woman if she plans to become pregnant.
7. If a woman plans to become pregnant, she should avoid eating certain types of fish.
8. Sexually transmitted infections (STDs) should be treated prior to a pregnancy.
9. The best time to start taking folic acid is at the very beginning of the pregnancy.
10. It is recommended to delay pregnancy for a couple of months after a woman decides to stop taking the pill or other hormonal contraceptive.
11. Recreational drugs (e.g. smoking joints) do not have an influence on a woman's fertility.
12. Recreational drugs (e.g. smoking joints) do not have an influence on a man's fertility.
13. Women who are planning to become pregnant and are not immune to toxoplasmosis (= infectious disease), should only eat well-done meat.
14. If a woman wants to become pregnant, she should drink no more than four cups of coffee a day.
15. Getting pregnant immediately after receiving a vaccine against rubella is safe.
16. Vitamin A decreases the risk of having a baby with a cleft lip or spina bifida.
17. At what age is there a decrease in women's ability to become pregnant?

5. Barriers

5.1 health literacy

1. I do not know where to find information.
2. I do not know what I can do to become pregnant in a healthy way.
3. Health advice is often too vague to apply in my life.
4. I find information about health often difficult to understand.
5. I do not know why you need to take folic acid when you want to become pregnant.

5.2 Emotions and beliefs

1. I think being overly concerned with becoming pregnant in a healthy way can scare my partner.
2. I think there are too many rules for becoming pregnant in a healthy way.
3. I think being overly concerned with becoming pregnant can have a negative influence on my fertility.
4. Reading information about becoming pregnant in a healthy way stresses me out beforehand.
5. If I adjust my way of life prior to a pregnancy (e.g. stop drinking alcohol) people around me will know that I am pregnant or wish to become pregnant

5.3 Religion

1. My religion is a barrier to prepare for pregnancy.

5.4 Financial issues

1. I find €10 per month too expensive for e.g. folic acid, help to stop smoking, guidance to lose weight…

5.5 Perceived need

1. I find myself healthy enough to become pregnant without preparations.

CHAPTER 7

THE INTENTION TO PREPARE FOR PREGNANCY IN MEN: ASSOCIATED SOCIO-DEMOGRAPHIC AND PSYCHOSOCIAL FACTORS

Based on the article of Goossens, J., Van Hecke, A., Beeckman, D.*, Verhaeghe, S.* (2018). The intention to prepare for pregnancy in men: associated socio-demographic and psychosocial factors. Submitted to Midwifery. Category NURSING: 21/115 (Q1) – IF 1.79. *Shared last authorship

ABSTRACT

BACKGROUND: Preconception health and care is to assure women and men are healthy before pregnancy to improve reproductive outcomes. No study has investigated psychosocial factors associated with male preconception health behaviors or behavioral intentions.

AIM: To explore socio-demographic and psychosocial factors associated with the overall intention to prepare for pregnancy and specific preconception health behaviors in the general population of reproductive-aged men.

METHODS: A cross-sectional, multicenter study was conducted with a convenience sample of 304 reproductive-aged men recruited between July 2015 and July 2016. An existing questionnaire was adapted and validated to assess the intention, self-efficacy, attitude, social influence, knowledge, and barriers towards 10 preconception health behaviors (adopting a healthy lifestyle, searching information/advice; avoiding testicular hyperthermia; attending preconception care; supporting partner; smoking and alcohol cessation/reduction; losing weight; discussing medication/herb use). Simple and multiple logistic and linear regression analyses were performed.

FINDINGS: The overall intention to prepare for pregnancy was high (median score: 0.7 on the 0–1 scale). The multiple linear regression revealed that self-efficacy (p<0.001), social influence of the close social environment (p=0.02), and attitude (p=0.05) were associated with a higher intention score. Experiencing negative emotions and beliefs about pregnancy preparations were associated with less intention for preconception health behaviors (p=0.001). None of the socio-demographic factors were significantly associated with the intention score.

DISCUSSION: The overall intention to prepare for pregnancy was high, and associated with different psychosocial factors including self-efficacy, social influence, and attitude. Preconception interventions should target the identified factors to improve preconception health behaviors in men.

Key words: ASE model; Behavior and Behavior Mechanisms; Associated factors; Intention; Men; Preconception behavior.

Statement of Significance

Problem

Research about psychosocial factors associated with the intention to prepare for pregnancy in reproductive-aged men is lacking.

What is Already Known

Most reproductive-aged men (83%) do not prepare for pregnancy. First-time fathers and those who used assisted reproductive technology to conceive are more likely to report preconception lifestyle adjustments.

What this Paper Adds

An overview of modifiable factors associated with the intention to prepare for pregnancy in the general population of reproductive-aged men including attitude, self-efficacy, and social influence. These factors should be addressed in preconception health interventions to improve preconception health behaviors in men.

INTRODUCTION

Preconception health and care are no new concepts, but have only been gaining attention in the last four decades (Moos and Cefalo, 1987; Hood et al., 2007). The basic idea of preconception health and care is to assure that a woman and man are healthy before they become pregnant to improve pregnancy outcomes and reduce adverse reproductive outcomes (Johnson et al., 2006; World Health Organization, 2012). Although preconception guidelines recommend to focus on both women and men (Johnson et al., 2006), women remain the primary target of preconception care. Nevertheless, several studies suggest that preconception health and care for men are important for several reasons (Frey et al., 2008). First, men are encouraged to be involved in family planning and contraceptive decision making (Frey et al., 2008). Second, improving men's health can lead to improved pregnancy outcomes as sperm DNA can get damaged by environmental and lifestyle influences, including tobacco, drugs, alcohol, testicular hyperthermia, medical conditions, medication, and environmental toxins. Sperm damage can lead to sub- or infertility, miscarriage, and birth defects (Frey et al., 2008). Third, optimizing men's health status can enhance the health and health behaviors of their female partner (Frey et al., 2008). A healthy lifestyle of men can be encouraging and supportive for maternal health behaviors. For example, it will be easier for a woman to stop smoking if her partner also stops. Fourth, it is a first step to involve men in pregnancy, childbirth, and parenthood, and prepare them for fatherhood (Frey et al., 2008).

Although preconception health and care are important for men, to date, little attention has been paid to improving the preconception health status of men. Only few studies have investigated preconception health behaviors in men and its associated factors. The Swedish study of Bodin et al. (2017) was the first study to investigate preconception lifestyle adjustments in a general male population (n= 796). Their findings suggest that most men (83%) did not made any preconception lifestyle adjustment to improve health and fertility. First-time fathers and those who had used assisted reproductive technology to conceive were more likely to report a preconception lifestyle adjustment (Bodin et al., 2017). No associations were found between preconception health behaviors and education or country of birth (Bodin et al., 2017). To further inform and improve intervention development for enhancing preconception health behaviors in men, it is important to gain insight into psychosocial and socio-demographic factors associated with preconception behavior or behavioral intentions (Bartholomew Eldrigde et al., 2016). To the authors knowledge, no studies have been

conducted on psychosocial factors associated with preconception health behaviors or behavioral intentions in a general population of men. Therefore, the goal of this study was to explore which socio-demographic and psychosocial factors were associated with the overall intention to prepare for pregnancy and specific preconception health behaviors in reproductive-aged men.

PARTICIPANTS, ETHICS AND METHODS

Participants

The study used a cross-sectional design with a convenience sample of men aged 15 – 45, who want to have (more) children, and able to read Dutch or English. Respondents completed an anonymous questionnaire about preconception health and lifestyle changes. The participants in this study were recruited between July 2015 and July 2016 from a variety of settings in an attempt to obtain a representative sample, including four secondary schools (general/ technical/ vocational secondary education; 4^{th} – 7^{th} year), four Public Centers for Social Welfare ('OCMW'), seven Community Health Centers, and through social media and websites of public agencies and other organizations in Flanders (Dutch-speaking northern region of Belgium). The study was approved by the Ethical Committee Ethical Committee of Ghent University Hospital (B670201422053).

Questionnaire development and validation

The questionnaire was adapted from an existing questionnaire on preconception health and lifestyle changes in women (Goossens et al., 2018). The original questionnaire for women was developed based on a literature review, qualitative research using semi-structured interviews in 15 women, national and international recommendations on preconception health and care, and the Attitude – Social Influence – Self-efficacy (ASE) model. The ASE-model is a social psychology model that suggests that the intention to perform a certain behavior predicts this behavior. The behavioral intention is in turn determined by three central psychosocial determinants: attitude, social influence, and self-efficacy; and barriers and skills play a role when the actual behavior is attempted (de Vries et al., 1988; Devries and Backbier, 1994; Lechner and Devries, 1995; De Vries et al., 1998). The final questionnaire for women consisted of 90 items grouped in 7 scales. The original questionnaire possessed good face, content, and construct validly, as well as internal consistency (Goossens et al., 2018). The original questionnaire was adapted based on available literature and guidelines on preconception health and care in men (Frey et al., 2008; Delbaere et al., 2016). Ten preconception health behaviors were selected on the basis of national and international guidelines on preconception health and care for men, including six general behaviors recommended for all men (adopting a healthy lifestyle; searching for information or advice on how to become pregnant in a healthy manner; eating healthy; avoiding scrotal

hyperthermia induced by e.g. sauna or hot baths; consulting a healthcare provider for information on preconception health; supporting the partner to adopt preconception lifestyle changes) and 4 specific preconception lifestyle changes for men reporting this unhealthy behavior or medical condition (stop smoking; alcohol reduction; losing weight; discussing medication or herb use with healthcare provider). The original items were adapted to the male population including rewording of items, removing irrelevant items, and adding new items, with the exception of the knowledge items, which were unaltered. The meaning and clarity of wording of the items, and the lay-out of the final questionnaire were evaluated using cognitive interviewing methods in a pilot test including 6 Dutch-speaking men with a mean age of 28.8 years (range: 24 – 35 years) and a desire to conceive. All men were higher educated and had the Belgian nationality. The final questionnaire consisted of 89 items grouped in seven scales, and was available in Dutch and English (Table 1).

Table 1. Instrument development and psychometric evaluation

Component	Description	N° of items	Response category	Psychometric evaluation	
				Construct validity: (1) Principal component analysis[c]; (2) Known-groups technique[d]; (3) Item validity[e]	***Reliability:*** (1) Internal consistency (Cronbach's α)[f]; (2) inter-item correlations (*r*)[g]; item-total correlations (*r*)[h]
Intention	Planning to make lifestyle changes before the partner becomes pregnant. Intention was assessed by asking, "Will you make this preparation? (*=Do you plan to make this preparation before your partner becomes pregnant?)*". Ten PC lifestyle changes were assessed: 6 general (living a healthy life; searching information/advice; eating healthy; avoiding testicular hyperthermia; attending a PC consult; supporting the partner) and 4 specific[a] PC lifestyle changes for men reporting this unhealthy behavior/medical condition (stop smoking; reducing alcohol consumption; losing weight; discussing medication/herb use with HC provider).	10	'Yes', 'No', 'NA'[b]	(1) NA (ǂ PC lifestyle changes) (2) Hypothesis confirmed: /	(1) NA (ǂ PC lifestyle changes) (2) NA (ǂ PC lifestyle changes) (3) NA (ǂ PC lifestyle changes)
Self-efficacy	The belief in the ability to perform lifestyle changes before the partner becomes pregnant. Self-efficacy was assessed by asking, "Can you make this preparation? *(= Do you think you are able to make this preparation, regardless whether or not you plan to make it?)* ". Ten PC lifestyle changes were assessed: 6 general and 4 specific[a] PC lifestyle changes.	10	'Yes', 'No', 'NA'[b]	(1) NA (ǂ PC lifestyle changes) (2) Hypothesis confirmed: level of education, income, native ethnicity, cohabiting relationship were positively associated with higher self-efficacy score (p-value:0.04–0.001)	(1) NA (ǂ PC lifestyle changes) (2) NA (ǂ PC lifestyle changes) (3) NA (ǂ PC lifestyle changes)
Attitude	Beliefs about positive and negative consequences of performing lifestyle changes before the partner becomes pregnant. Attitudes were measured by asking to score several beliefs about the positive and negative consequences of preparing for pregnancy.	8 → 4	6-point Likert: Completely disagree – Completely agree	(1) 4 items loaded onto 1 component, factor loadings: 0.60 – 0.85. The other 4 items loaded onto the 'barriers' component, and therefore, were analyzed as barriers. (2) Hypothesis confirmed: level of education and non-smoking were positively associated with higher attitude score (p-value: 0.03–0.01)	(1) α = 0.67 (2) All positive correlations (3) *r*= 0.34 – 0.61
Social influence	Social influences including social norm, pressure and support from (1) the close social environment (partner, family, friends, colleagues or fellow students), (2) HC providers, (3) other men, and (4) media, to perform lifestyle changes before the partner becomes pregnant were measured. (5) The importance of others' opinion about PC lifestyle changes was assessed by asking men to rate how important the opinion of their close social environment and HC caregivers is for them.	7 5	6-point Likert: Completely disagree – Completely agree 5-point Likert: Very unimportant – Very important	(1) 4 items on the social influence of the close social environment (partner, friends, family, colleagues or fellow students) loaded onto 1 component (factor loadings: 0.67–0.76). The item on social influence of HC providers, social norm, and media were analysed separately. The 5 items on the importance of the other's opinion about PH behaviors loaded onto 1 component (factor loadings: 0.54–0.76). (2) Hypothesis confirmed (social influences): lower educated, younger age, and lower income were positively associated with higher social influence score (p-value: 0.05 – <0.001). Hypotheses confirmed (importance of opinion):/	(1) α (close social environment)= 0.69; α (importance others' opinion)= 0.67 (2) All positive correlations (3) *r* (close social environment)=0.41–0.55; *r* (importance other's opinion)= 0.33 – 0.52

Component	Description	N° of items	Response category	Psychometric evaluation	
				Construct validity: (1) Principal component analysis[c]; (2) Known-groups technique[d]; (3) Item validity[e]	***Reliability:*** (1) Internal consistency (Cronbach's α)[f]; (2) inter-item correlations (r)[g]; item-total correlations (r)[h]
Knowledge	Knowledge was assessed with a true-false scale assessing knowledge about (1) tobacco, alcohol, and substance abuse, (2) nutrition, (3) family planning, (4) medication, and (5) infection diseases and immunization.	17	'True', 'False', 'I don't know'[2]	(1) NA (ǂ topics on PH) (2) Hypothesis confirmed: level of education, nulliparity, age, paid employment, and active desire for children were positively associated with higher knowledge score (p-value: 0.01 – <0.001) (3) Item difficulty: 15% – 82%; Discrimination index: 0.36 – 0.71.	(1) NA (ǂ topics on PH) (2) NA (ǂ topics on PH) (3) NA (ǂ topics on PH)
Barriers	Obstacles that make it difficult to perform lifestyle changes before the partner becomes pregnant. Costs, religion, health literacy, locus of control, stress, believing PH is a woman's task, perceived need, lack of energy or time, and medicalization of conception were included as barriers to perform PC lifestyle changes before the partner becomes pregnant.	8→12	6-point Likert scale: Completely disagree – Completely agree	(1) The items loaded onto 5 components: (1) health literacy, 4 items, factor loadings: 0.80 – 0.84; (2) emotions and beliefs, 5 items, factor loadings: 0.56 – 0.74; (3) religion, 1 item; (4) financial issues, 1 item; (5) perceived need, 1 item. (2) Hypothesis confirmed (health literacy): level of education and age were negatively associated with barrier score (p-value: 0.006 – <0.001); Hypothesis confirmed (emotions and belief): age was negatively associated with barrier score (p<0.001)	(1) α (health literacy)= 0.83; α (emotions and beliefs)= 0.64 (2) All positive correlations (3) r (health literacy)= 0.63 – 0.70; r (emotions and beliefs)=0.33– 0.49
Socio-demo-graphics	Sex, age, nationality, country of origin, parents' country of origin, religion, language proficiency, marital status, living situation, biological children, home environment, desire for children, smoking habits, alcohol consumption, height, weight, general health, medical condition, medication use, social support, educational level, paid employment, income, perceived poverty.	24	Depending on question	NA	NA

[a]Analyses were only performed on men reporting this unhealthy behavior or medical condition; [b]Response categories were dichotomized for analysis: 'yes' *versus* 'no'/'not applicable'(general PC lifestyle changes were applicable for all men) and 'correct' *versus* 'incorrect'/'I don't know' answer on knowledge items; [c]Factor analysis using principal component analysis with varimax rotation. Sample adequacy was confirmed by Kaiser-Meyer-Olkin test (>0.50) and Bartlett's test of sphericity (p<0.05). The number of factors (eigenvalues ≥1) and factor loadings (>0.40) were evaluated; [d]Literature on associated factors of self-efficacy, attitude, social influences, and barriers regarding preparing for pregnancy was scare. Therefore, hypothesis were based on literature about associated factors of preconception and fertility knowledge, intention and behavior in men and women (educational level, parity, age, income, paid employment, ethnicity, partnership status, smoking behavior, fertility treatment, and desire for children) using Mann-Whitney U & Kruskal Wallis tests; [d]Only for the knowledge component: item difficulty (ID) & discrimination index (DI), ID: % of respondents who answered question correctly, values recommended for ID are between 10% and 90%, DI: % of correct answers in the top 27% of respondents with highest score minus % of correct answers in lowest 27% of respondents with lowest score, DI values of 0.20-0.29 are considered as acceptable, 0.30-0.39 as good and 0.40 and above as excellent (Ebel, 1972); [f]Cronbach's α higher than 0.70 is considered as acceptable (Polit and Beck, 2010); [g]All items should be positively intercorrelated; [h]Scores above 0.2 indicating an acceptable correlation between each item and the overall score (Streiner et al., 2014); Abbreviations, HC: healthcare; NA, Not applicable; PC: preconception; PH: preconception health.

After completing the data-collection, the psychometric properties were evaluated by assessment of the construct validity and the reliability. Overall, the questionnaire showed acceptable construct validity and reliability with only minor comments (Table 1). Six theoretical components were identified: intention, self-efficacy, attitude (e.g., expecting to have increased chances of having a healthy baby, pregnancy as a natural process without need for preconception health behaviors), social influence, knowledge, and barriers. The social influence component consisted of five subgroups: social influence of important others (e.g., support from close social environment to prepare for pregnancy), social norm (e.g., other men also prepare for pregnancy), social influence of healthcare provider (e.g., healthcare providers recommend preconception health behaviors), and social influence of media (e.g., pressured by media to prepare for pregnancy), and the importance of other's opinion regarding preconception health behaviors (e.g. partner, healthcare providers). The barriers component comprised five subgroups: poor health literacy (e.g., not knowing where to find information), negative emotions and beliefs (e.g., stress due to preconception health information, little control of unborn child, preparing for pregnancy is a woman's task), religious beliefs (e.g., religion as a barrier to prepare for pregnancy), financial issues (e.g., preconception health behaviors are too expensive), and lack of perceived need (e.g., finding yourself healthy enough to conceive without preconception lifestyle adjustments)(Supplementary data).

Procedure

To allow optimal access to the target population, three methods were used to recruit participants for this study. Firstly, 11 secondary schools were invited to participate, of which four schools agreed. The teachers distributed the paper questionnaires to the students during class time. The students completed the questionnaire and returned it in a closed envelope. In total, 174 men were recruited through this method. Secondly, posters in waiting rooms of four Public Centers for Social Welfare ('OCMW') and seven Community health centers explained the aim of the study. Men were invited to complete the questionnaire while waiting for the appointment, and deposit it in a sealed collection box at the site. Twenty-five men were recruited through this second method. Thirdly, the questionnaire was available online and was distributed through social media and several websites of public agencies and other organizations. To improve the response rate, one gift voucher of €50 was raffled off among the male participants that completed the online questionnaire. In total, 165 men were recruited through social media and websites.

Data analysis

Questionnaires with more than 25% missing values were discarded from analysis. Descriptive analyses were performed for all variables with calculations of means and medians for continuous variables and proportions

for categorical variables. A total preconception behavioral intention and self-efficacy score was calculated by averaging the scores of the ten intention and self-efficacy items, respectively. A total attitude, social influence, knowledge, and barrier score was obtained by summing the scores of the items within each scale.

All ten preconception behavioral intentions were analyzed separately. Simple logistic regression analyses were carried out to explore significant socio-demographic and psychosocial factors associated with the intention to perform a preconception behavior. Independent variables with p≤ 0.10 were included in the multiple logistic regression analysis.

The overall intention score was not normally distributed, and therefore, nonparametric tests were applied. Spearman's rho correlations were used to evaluate associations between the psychosocial factors and overall behavioral intention. Simple linear regression analyses with bootstrapping methods (10 000 bootstrapping samples) were performed to examine the association between the overall intention score and each psychosocial factor or socio-demographic factor. Independent variables with p≤ 0.10 were included in the multiple linear regression analysis with bootstrapping methods (10 000 bootstrapping samples).

The 'enter' regression method was used for all regression analyses. Prior to the multiple regression analyses, independent variables were checked for multicollinearity using tolerance values and variance inflation factor (VIF). Statistics showed that each independent variable had a tolerance value of more than 0.40, hence multicollinearity was not considered a problem in our analyses. The items on income and perceived poverty, and fertility treatment were sub-questions that were skipped if respondents were students or had no biological children, respectively. Because of the high number of missing values for these variables, they were not entered in the multiple model. Data were analyzed using SPSS version 21 (IBM Corporation, Armonk, NY, USA). All test were two-sided and $p<0.05$ was regarded as statistically significant.

RESULTS

In total, 364 men completed the questionnaire. Nine of them did not meet the age criteria, 47 had no desire for (more) children, and four had more than 25% missing values. The final sample comprised 304 men with an average age of 22.0 years [standard deviation (±): 6.4]. Approximately one in three men (33.6%) were educated at bachelor's or master's level. Most men had a Belgian nationality (94.7%), no biological children (86.8%), and no desire to conceive in the coming year (87.5%)(Table 2).

Table 2. Characteristics of the respondents (n= 304)

Variable	Mean (SD)	Median (range)
Age (years)	22.0 (6.4)	19 (15.0 – 42.0)
BMI (kg/m²)	22.7 (3.8)	22.2 (13.9 – 48.4)
Variable	**n**	**%**
Ethnicity		
Immigrants[a]	45	15
Natives	256	85
Partnership status		
Relationship	162	54.2
No relationship	132	45.8
Education[b]		
Low	202	66.4
High	102	33.6
Paid employment[c]		
Yes	96	91.4
No	9	8.6
Net household income[c]		
< €2.000	31	29.5
€2.000 - €2.999	23	21.9
> €3.000	51	48.6
Perceived poverty: making ends meet…[c,d]		
Easy	88	86.3
Difficult	14	13.7
Biological children		
Yes	40	13.2
No	263	86.8
History of fertility treatment[e]		
Yes	6	17.1
No	29	82.9
Preconception consult before previous pregnancy?[e]		
Yes	23	63.9
No	13	36.1
Desire for children		
Within one year	37	12.5
Longer than one year	260	87.5
Smoking		
Yes	44	14.5
No	259	85.5
Alcohol use		
Yes	241	79.5
No	62	20.5
Serious medical condition		
Yes	22	7.2
No	282	92.8
Long-term medication use		
Yes	44	14.6
No	258	85.4

[a]One or both of the parents born outside Belgium; [b]Low level of education: primary, secondary or post-secondary education versus high level of education: college or university education; [c]Only questioned in non-student population (n=105); [d]Perceived poverty was measured by asking "how easy or difficult is it to make ends meet?"; [e]Only questioned in men who reported having biological children; Abbreviations, BMI, Body Mass Index; SD: standard deviation.

Psychosocial factors

Men had a positive attitude (median score: 15.0 on the 4–21 scale) and high self-efficacy (median score: 1.0 on the 0–1 scale) towards preparing for pregnancy (Table 3). Men were most sensitive to social influences of healthcare providers (median score: 4.0 on the 1–6 scale) and their close social environment (median score: 17.0 on the 4–24 scale). The opinion of the (future) partner about preparing for pregnancy was assessed as most important, followed by the opinion of healthcare providers, with a median score of 6.0 and 5.0 on the 1–6 scale, respectively. The total knowledge score was moderate with a median score of 9.0 on the 0–17 scale. The knowledge about tobacco, alcohol, and drug abuse was high with 72.0% to 80.5% correct answers. Contrary, the knowledge about folic acid (15.6% – 32.6% correct answers), vaccination (33.7%), and preventive measures for foodborne infections (20.5% – 35.4% correct answers) was low. Overall, most men experienced few barriers regarding preconception lifestyle changes. The most reported barrier was the lack of perceived need for preconception health behaviors (median score: 5.0 on the 1–6 scale).

Table 3. Spearman's rho correlations and descriptive statistics for all psychosocial variables (n= 304)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Intention (overall score)		0.27**	0.36**	0.17**	0.08	0.07	0.10	0.10	0.08	-0.12*	-0.30**	-0.05	-0.17**	-0.13*
2. Attitude			0.15*	0.26**	0.05	0.26**	0.06	0.08	0.15*	-0.09	-0.22**	-0.07	-0.05	-0.19**
3. Self-efficacy (overall score)				-0.08	-0.15**	0.03	-0.07	0.09	0.26**	-0.16**	-0.17**	-0.18**	-0.06	-0.05
4. Social influence close environment					0.49**	0.46**	0.30**	0.16**	-0.09	-0.004	-0.07	0.06	-0.11*	0.05
5. Social norm						0.40**	0.35**	0.07	-0.22**	0.20**	0.09	0.27**	0.11	-0.04
6. Social influence healthcare providers							0.33**	0.10	-0.12*	0.10	-0.008	0.09	0.01	-0.04
7. Social influence media								-0.04	-0.05	0.25**	0.13*	0.16**	0.12*	-0.10
8. Importance of others' opinion									-0.01	0.04	-0.02	0.05	-0.04	0.04
9. Knowledge										-0.30**	-0.29**	-0.27**	-0.14*	0.06
10. Barriers: health literacy											0.51**	0.32**	0.43**	-0.05
11. Barriers: emotions and beliefs												0.18**	0.35**	-0.01
12. Barriers: religion													0.25**	-0.001
13. Barriers: financial														-0.04
14. Barriers 5: perceived need														
Mean (SD)	0.71 (0.22)	14.82 (3.00)	0.88 (0.17)	17.40 (2.90)	3.35 (1.13)	4.03 (1.13)	2.95 (1.24)	22.98 (3.21)	8.72 (3.34)	10.27 (3.74)	13.59 (4.04)	1.54 (1.06)	2.19 (1.35)	4.37 (1.13)
Median (range)	0.71 (0 – 1)	15,00 (4 – 21)	1.00 (0 – 1)	17.00 (4 – 24)	3.00 (1 – 6)	4.00 (1 – 6)	3.00 (1 – 6)	23.00 (8 – 30)	9.00 (0 – 16)	10.00 (4 – 23)	14.00 (5 – 28)	1.00 (1 – 6)	2.00 (1 – 6)	5.00 (1 – 6)

*Correlation is significant at 0.05 level; **Correlation is significant at 0.01 level.

Preconception health behaviors: associated socio-demographic and psychosocial factors

Intention to adopt a healthy lifestyle

The majority of the men (n= 255, 85.3%) had the intention to adopt a healthy lifestyle in the preconception period. The results of the multiple logistic regression analysis showed that higher self-efficacy to adopt a healthy lifestyle [Odds Ratio (OR) 5.67, 95% Confidence Interval (CI) 1.15 – 27.99] and more social influence of the close social environment (OR 1.20, 95% CI 1.04 – 1.38) increased the odds of intending to adopt a healthy lifestyle. Experiencing negative emotions and beliefs about preparing for pregnancy, such as stress and the belief that preconception health and care is a medicalization of conception (OR 0.87, 95% CI 0.78 – 0.96), decreased the likelihood of this behavioral intention. Age was positively associated (OR 1.11, 95% CI 1.01 – 1.22), while smoking was negatively associated (OR 0.23, 95% CI 0.09 – 0.59) with the intention to adopt a healthy lifestyle preconceptionally. This model explained 23% of the variance (Nagelkerke R^2= 0.23)(Table 4).

Table 4. Summary of multiple logistic regression analysis[a] for socio-demographic and psychosocial factors associated with individual preconception behavioral intentions

Variable	*B*	SE	p-value	OR	95% CI
Intention to adopt a healthy lifestyle (n= 282)					
Attitude	0.07	0.07	0.32	1.07	0.94 – 1.22
Self-efficacy to adopt a healthy lifestyle	1.73	0.82	0.03	5.67	1.15 – 27.99
Social influence close social environment	0.18	0.07	0.01	1.20	1.04 – 1.38
Barrier: emotions and beliefs	-0.14	0.05	0.007	0.87	0.78 – 0.96
Age	0.10	0.05	0.04	1.11	1.01 – 1.22
Education: high	-0.18	0.59	0.76	0.83	0.27 – 2.62
Smoking: yes	-1.46	0.47	0.002	0.23	0.09 – 0.59
Intention to search for information or advice on how to become pregnant in a healthy way (n= 268)					
Attitude	0.04	0.07	0.55	1.04	0.91 – 1.19
Self-efficacy to search information/advice	2.81	0.64	<0.001	16.55	4.75 – 57.73
Social influence close social environment	0.16	0.07	0.02	1.18	1.02 – 1.35
Social influence healthcare providers	0.12	0.19	0.51	1.13	0.78 – 1.65
Knowledge	-0.008	0.07	0.91	0.99	0.87 – 1.13
Barrier: health literacy	-0.02	0.06	0.70	0.98	0.86 – 1.10
Barrier: emotions and beliefs	-0.07	0.06	0.23	0.94	0.84 – 1.04
Barrier: religion	-0.44	0.19	0.02	0.64	0.44 – 0.94
Barrier: financial	-0.16	0.14	0.26	0.85	0.65 – 1.12
Barrier: perceived need	-0.37	0.19	0.047	0.69	0.48 – 0.99
Education: high	-0.56	0.45	0.21	0.57	0.24 – 1.37

Variable	*B*	SE	p-value	OR	95% CI
Intention to eat healthy (n= 266)					
Attitude	0.07	0.08	0.41	1.07	0.91 – 1.25
Self-efficacy to eat healthy	3.36	1.12	0.003	28.64	3.18 – 258.01
Social influence close social environment	0.21	0.10	0.04	1.23	1.01 – 1.50
Social norm	0.52	0.26	0.04	1.69	1.01 – 2.82
Importance of other's opinion	0.11	0.07	0.12	1.12	0.97 – 1.29
Knowledge	-0.09	0.09	0.29	0.91	0.77 – 1.08
Barrier: emotions and beliefs	-0.19	0.06	0.003	0.83	0.73 – 0.94
Age	0.26	0.08	0.001	1.30	1.11 – 1.53
Education: high	0.66	0.76	0.39	1.93	0.43 – 8.62
Relationship: yes	1.19	0.56	0.03	3.29	1.11 – 9.76
Smoking: yes	-1.98	0.60	0.001	0.14	0.04 – 0.44
Intention to avoid testicular hyperthermia (n= 267)					
Attitude	0.07	0.05	0.19	1.07	0.97 – 1.18
Self-efficacy to avoid hyperthermia	3.34	0.74	<0.001	28.29	6.63 – 120.63
Social influence close social environment	0.08	0.05	0.10	1.08	0.98 – 1.19
Barrier: emotions and beliefs	-0.02	0.04	0.59	0.98	0.91 – 1.05
Barrier: financial	-0.11	0.12	0.37	0.90	0.72 – 1.13
Ethnicity: natives	-0.32	0.44	0.46	0.72	0.31 – 1.72
BMI: overweight/obesity	0.57	0.35	0.10	1.77	0.89 – 3.51
Intention to attend a preconception consult with a healthcare provider (n= 279)					
Attitude	0.04	0.06	0.43	1.04	0.94 – 1.16
Self-efficacy to attend a PC consult	4.92	1.23	<0.001	137.45	12.43 – 1519.95
Social influence close social environment	0.08	0.05	0.15	1.08	0.97 – 1.19
Importance of other's opinion	0.05	0.05	0.34	1.05	0.95 – 1.17
Barriers: emotions and beliefs	-0.08	0.04	0.05	0.93	0.86 – 1.00
Barriers: perceived need	-0.21	0.14	0.14	0.81	0.62 – 1.07
Age	-0.05	0.03	0.08	0.95	0.90 – 1.01
Biological children: yes	0.07	0.51	0.89	1.07	0.39 – 2.92
History of fertility treatment[b]	/	/	/	/	/
Serious medical condition: yes	2.68	1.15	0.02	14.61	1.54 – 138.32
Intention to support the partner to perform preconception lifestyle changes (n= 286)					
Attitude	0.05	0.16	0.74	1.05	0.77 – 1.44
Self-efficacy to support the partner	-	-	0.99	0.00	-
Social influence close social environment	0.21	0.17	0.21	1.24	0.89 – 1.72
Social influence healthcare providers	0.76	0.54	0.16	2.14	0.74 – 6.20
Barrier: religion	-0.93	0.42	0.03	0.40	0.18 – 0.90

Variable	*B*	SE	p-value	OR	95% CI
Intention to stop smoking (n= 42)					
Self-efficacy to stop smoking	1.32	1.09	0.23	3.74	0.44 – 31.58
Barrier: emotions and beliefs	-0.17	0.11	0.13	0.85	0.68 – 1.05
Barrier: perceived need	-0.30	0.33	0.37	0.74	0.39 – 1.42
Education: high	1.51	0.91	0.10	4.54	0.76 – 27.18
Income[b]	/	/	/	/	/
Biological children: yes	1.41	0.90	0.12	4.10	0.70 – 29.91
Intention to reduce alcohol consumption (n= 229)					
Attitude	0.17	0.06	0.003	1.19	1.06 – 1.33
Self-efficacy to reduce drinking alcohol	3.77	0.75	<0.001	43.32	10.00 – 187.84
Age	-0.05	0.03	0.049	0.95	0.90 – 1.00
Income[b]	/	/	/	/	/
Intention to lose weight (n= 57)					
Self-efficacy to lose weight	3.48	1.30	0.008	32.40	2.53 – 415.45
Social influence media	0.76	0.35	0.03	2.13	1.08 – 4.20
Age	0.11	0.08	0.17	1.11	0.95 – 1.30
Education: high	-1.04	0.85	0.22	0.36	0.07 – 1.89
Income[b]	/	/	/	/	/
Intention to discuss medication or herb use with healthcare provider					
Importance of other's opinion	0.15	0.13	0.23	1.17	0.91 – 1.50
Barrier: perceived need	-0.63	0.36	0.09	0.54	0.26 – 1.09
Alcohol: yes	1.68	0.95	0.08	5.38	0.84 – 34.58

[a]All variables with a p-value of ≤ 0.10 in the simple regression analysis were included; [b]Not included in the multiple regression model due to missing data. Abbreviations, *B*: Beta; BMI, Body Mass Index; CI, Confidence Interval; SE, standard error; OR, Odds Ratio; PC, preconception.

Intention to search for information or advice on how to become pregnant in a healthy way

Overall, 77.8% (n= 231) of the studied men had the intention to search for information or advice on how to become pregnant in a healthy manner. Self-efficacy to search for information or advice (OR 16.55, 95% CI 4.75 – 57.73) and social influence of the close social environment (OR 1.18, 95% CI 1.02 – 1.35) were positively associated with this behavioral intention. Lack of perceived need for preconception health behaviors (OR 0.69, 95% CI 0.48 – 0.99) and religious beliefs as barrier to prepare for pregnancy (OR 0.64, 0.44 – 0.94) decreased the likelihood of intending to search for information or advice. This model explained 33% of the variance of the intention to search for information or advice (Nagelkerke R^2= 0.33)(Table 4).

Intention to eat healthy

Most men (85.2%, n= 253) had the intention to eat healthy during the preconception period. Higher self-efficacy to adopt healthy eating habits (OR 28.64, 95% CI 3.18 – 258.01), being sensitive to the social influence of the close social environment (OR 1.23, 95% CI 1.01 – 1.50), and expecting that other men also prepare for pregnancy (OR 1.69, 95% CI 1.01 – 2.82) increased the odds of intending to eat healthy in the preconception period. Experiencing negative emotions and beliefs about preparing for pregnancy (OR 0.83, 95% CI 0.73 – 0.94) decreased the intention to adopt healthy eating habits. In addition, age (OR 1.30, 95% CI 1.11 – 1.53) and being in a relationship (OR 3.29, 95% CI 1.11 – 9.76) were positively associated, while smoking (OR 0.14, 95% CI 0.04 – 0.44) was negatively associated with this behavioral intention. This model explained 38% of the variance (Nagelkerke R^2= 0.38)(Table 4).

Intention to avoid testicular hyperthermia

Less than half of the men (n= 136, 45.8%) had the intention to avoid testicular exposure to environmental heat (e.g. sauna or hot baths) during the preconception period. In the multiple regression analysis, only self-efficacy to avoid testicular hyperthermia (OR 28.29, 95% CI 6.63 – 120.63) was positively associated with this behavioral intention. This model explained 30% of the variance (Nagelkerke R^2= 0.30)(Table 4).

Intention to attend a preconception consult with a healthcare provider

Approximately half of the men (n= 152, 51.5%) intended to consult a healthcare provider for preconception care. Higher self-efficacy to attend a preconception consult (OR 137.45, 95% CI 12.43 – 1519.95) and having a serious medical condition (OR 14.61, 95% CI 1.54 – 138.32) increased the likelihood of intending to consult a healthcare provider in the preconception period. Experiencing negative emotions and beliefs about preparing for pregnancy decreased the odds for this behavioral intention, but the association was only borderline significant (OR 0.93, 95% CI 0.86 – 1.00). This model explained 38% of the variance (Nagelkerke R^2= 0.38)(Table 4).

Intention to support the partner to perform preconception lifestyle changes

Almost all men (97.6%, n= 290) had the intention to support their partner to adopt preconception lifestyle changes. In the multiple regression analysis, only religious beliefs as barrier to prepare for pregnancy (OR 0.40, 95% CI 0.18 – 0.90) were negatively associated with the intention to support the partner. This model explained 27% of the variance (Nagelkerke R^2= 0.27)(Table 4).

Intention to stop smoking

Forty-four men (14.5%) reported to smoke. Twenty-five men (58.1%) had the intention to stop smoking in the preconception period. None of the independent variables remained significantly associated with this behavioral intention. This model explained 39% of the variance (Nagelkerke R^2= 0.39)(Table 4).

Intention to reduce alcohol consumption

Four in five men (n= 241) consumed alcohol, of whom 41.5% (n=100) intended to reduce the alcohol consumption in the preconception period. Having a positive attitude towards preparing for pregnancy (OR 1.19, 95% CI 1.06 – 1.33) and higher self-efficacy to reduce drinking alcohol (OR 43.32, 95% CI 10.00 – 187.84) increased the likelihood of this behavioral intention. Age (OR 0.95, 95% CI 0.90 – 1.00) was negatively associated with the intention to reduce alcohol consumption in the preconception period. This model explained 38% of the variance (Nagelkerke R^2= 0.38)(Table 4).

Intention to lose weight

Twenty per cent of the men (n= 59) had Body Mass Index (BMI) above 25 kg/m². Less than half of this subgroup (43.9%, n= 25) intended to lose weight preconceptionally. Higher self-efficacy to lose weight (OR 32.40, 95% CI 2.53 – 415.45) and experiencing social pressure from the media to prepare for pregnancy (OR 2.13, 95% CI 1.08 – 4.20) increased the likelihood of this behavioral intention. This model explained 52% of the variance (Nagelkerke R^2= 0.52)(Table 4).

Intention to discuss medication or herb use with healthcare provider

Forty-four men (14.6%) indicated long-term medication use, of which anti-allergic (n=13), endocrine (n=8), and psychostimulants (n=6) drugs were most frequently reported. Twenty-four (54.5%) of this subgroup had the intention to discuss medication use with a healthcare provider in the preconception period. None of the independent variables remained significantly associated with the intention to discuss medication or herb use with a healthcare provider in the preconception period. This model explained 26% of the variance (Nagelkerke R^2= 0.26)(Table 4).

Overall intention to prepare for pregnancy: associated socio-demographic and psychosocial factors

The overall preconception behavioral intention score was high (median score: 0.7 on the 0–1 scale). Self-efficacy (r_s = 0.36, p < 0.001), attitude (r_s = 0.27, p < 0.001), and social influence from the close social environment (r_s = 0.17, p < 0.001) were positively associated with the intention to prepare for pregnancy. The strongest barrier to prepare for

pregnancy was having negative emotions and beliefs about pregnancy preparations (r_s = -0.30, p < 0.001), followed by financial barriers (r_s = -0.17, p < 0.001), lack of perceived need (r_s = -0.13, p < 0.05), and poor health literacy (r_s = -0.12, p < 0.05). Knowledge, social norm, social influence of healthcare providers and media, the importance of others' opinion, and religion as a barrier were not significantly associated with the overall intention score (Table 3). The results of the multiple linear regression analysis indicated that self-efficacy [Beta [*B*]= 0.39, Standard Error [SE]= 0.10, p< 0.001] and social influence of the close social environment (*B*= 0.01, SE= 0.005, p= 0.02) were positively associated with the intention to prepare for pregnancy. A positive attitude was also positively associated with a higher intention to prepare for pregnancy, but the association was only borderline significant (*B*= 0.01, SE= 0.004, p= 0.05). In addition, the experience of negative emotions and beliefs about pregnancy preparations was negatively associated with the intention to prepare for pregnancy (*B*= 0.01, SE= 0.003, p= 0.001). This model explained 24% of the variance of the intention to prepare for pregnancy (R^2 = 0.27, adjusted R^2 = 0.24) (Table 5).

Table 5. Summary of multiple linear regression analysis[a] with bootstrapping methods (10 000 bootstrapping samples) for socio-demographic and psychosocial factors associated with the overall intention to prepare for pregnancy (n= 280)

Variable	*B*	SE	p-value	95% CI
Attitude	0.01	0.004	0.05	0.00 – 0.02
Self-efficacy (overall score)	0.39	0.10	<0.001	0.21 – 0.59
Social influence close social environment	0.01	0.005	0.02	0.002 – 0.02
Social norm	0.02	0.01	0.24	-0.02 – 0.04
Social influence media	0.01	0.01	0.28	-0.01 – 0.03
Barrier: emotions and beliefs	-0.01	0.003	0.001	-0.02 – -0.01
Barrier: financial	-0.01	0.01	0.29	-0.03 – 0.01
Barrier: perceived need	-0.01	0.01	0.27	-0.04 – 0.01
Desire for children: longer than one year	-0.06	0.03	0.07	-0.12 – 0.01

[a]All variables with a p-value of ≤ 0.10 in the simple regression analysis were included; Abbreviations, *B*: Beta; CI, Confidence Interval; SE, standard error.

DISCUSSION

This study provided insight into which socio-demographic and psychosocial factors were associated with the overall intention to prepare for pregnancy and specific preconception health behaviors.

Overall intention to prepare for pregnancy

Our findings showed that men had a high overall intention to prepare for pregnancy, with a median intention score of 0.7 on the 0–1 scale. These results differ from those of Bodin et al. (2017), who found that only 17% of the fathers

reported a lifestyle adjustment in preparation of pregnancy. These differences can be explained by the fact that Bodin et al. (2017) measured behavior, while we investigated the intention to perform the behavior. The ASE model assumes that behavior is determined by the behavioral intention to perform it (de Vries et al., 1988; De Vries et al., 1998). However, intention does not always lead to health behavior change because it can be influenced by other factors such as skills (e.g. knowledge, coping skills) or barriers (e.g. financial barriers, time, energy) (de Vries et al., 1988; De Vries et al., 1998).

Self-efficacy, social influence of the close social environment, and attitude towards preparing for pregnancy were positively associated with the overall intention to prepare for pregnancy, although the latter association was only borderline significant (p= 0.05) in the multiple regression analysis. These findings support the use of the ASE model in predicting preconception health behaviors in men. Self-efficacy was the strongest correlate of the overall intention to prepare for pregnancy. This finding is in line with previous studies, which reported a strong relation between self-efficacy and health behaviors or behavioral intentions, including the intention to prepare for pregnancy in women (Goossens et al., 2018), intention to practice testicular self-examination (Lechner et al., 2002), intention to discuss birth control with female partner (Masters et al., 2017), and fruit and vegetable consumption in men during parenthood transitions (Bassett-Gunter et al., 2013). Social influence of the close social environment to prepare for pregnancy was the only social influence that remained significantly associated with overall intention in the multiple regression model. This finding is somewhat surprising because no significant association was found in the analogous study with women (Goossens et al., 2018). In addition, one would expect that healthcare providers have a significant influence on the intention to prepare for pregnancy because previous findings showed that healthcare providers are the preferred source of preconception health information and care (Frey and Files, 2006; Frey et al., 2012; Goossens et al., 2016). However, the association between the overall intention and social influence of healthcare providers to prepare for pregnancy was not significant in both men (p= 0.22) and women (p= 0.53)(Goossens et al., 2018).

The only significant barrier to the intention to prepare for pregnancy was the experience of negative emotions and beliefs about preparing for pregnancy, such as stress, lack of control over the health of an unborn child, medicalization of the conception, the perception that becoming pregnant in a healthy way is a woman's task, and lack of time or energy. This finding is consistent with previous studies in women (Poels et al., 2016; Goossens et al., 2018). Surprisingly, lack of perceived need for preconception lifestyle changes was not significantly associated with overall intention, although it was the most reported barrier (median score: 5.0 on the 1–6 scale).

Furthermore, knowledge about preconception health and fertility was no factor associated with the intention to prepare for pregnancy. This finding is in line with other research studies that found no association between knowledge and preconception health behavior in women (Delissaint and McKyer, 2011; Temel et al., 2013), but contrary to the findings of the analogue study regarding the intention to prepare for pregnancy in women (Goossens et al., 2018). The knowledge was the highest on the influence of tobacco (76% – 80% correct answers), alcohol (72% correct answers), and drug use (79% – 81%) on fertility and pregnancy, and is in agreement with those of previous studies in men and women (Frey et al., 2012; Charafeddine et al., 2014; Goossens et al., 2018). The knowledge was the lowest on folic acid (16% – 33% correct answers), vaccination (34%), and preventive measures for foodborne infections (21% – 35% correct answers), and is consistent with the findings of the analogue study in women (Goossens et al., 2018). However, overall, women's lowest knowledge scores were still higher compared those of men, and is in line with previous studies (Mitchell et al., 2012; Charafeddine et al., 2014; Temel et al., 2015).
No association was found between socio-demographic factors and the overall intention to prepare for pregnancy. This outcome is contrary to that of Bodin et al. (2017) who found an association between preconception lifestyle adjustments, and first-time fathers and the use of assisted reproductive technology (ART). A possible explanation for these results may be the small subsample of men having biological children (n= 40) and using ART to conceive (n= 6) in our study.

Intention for specific preconception health behaviors

The highest intention rates were for supporting the partner to adopt a healthy lifestyle in the preconception period (98%), adopting a healthy lifestyle (85%), and eating healthy (85%). The lowest intention scores were for losing weight (44%) and reducing alcohol consumption (42%) in the preconception period. These results are the opposite of those of Bodin et al. (2017) who found that reducing or quitting consumption of alcohol (7%) and increasing exercise (5%) were the most common preconception lifestyle adjustments. Although the impact of alcohol consumption on the male reproductive function is still controversial, several studies have shown negative effects of alcohol on sperm parameters and male fertility (La Vignera et al., 2013; Fullston et al., 2017; Ricci et al., 2017). Similar findings were found in studies on the impact of overweight and obesity on male fertility and semen parameters (Sermondade et al., 2013; Campbell et al., 2015; Fullston et al., 2017), and support the importance of preconception health interventions to obtain a healthy weight and reduce alcohol consumption in men preconceptionally.

Overall, the psychosocial factors associated with individual preconception behavioral intentions were similar to those associated with the total preconception intention score, which is logical since the overall score was computed by averaging the individual intention items. No psychosocial factors remained significantly associated with the intention to stop smoking and to discuss medication or herb use with a healthcare provider, indicating that other factors may be more important influences on these behavioral intentions (Lechner et al., 1997). The ASE model and other social-cognitive models are grounded on the belief that behavior is the result of a rational decision or plan (Sniehotta et al., 2014). However, people do not always make rational and calculated decisions; routine habits and unconscious influences might also influence behavior, which is not captured by the ASE model (Deutsch and Strack, 2006; Hoffman et al., 2008; Frankish, 2010; Sniehotta et al., 2014).

Methodological considerations

To the best of our knowledge, this was the first study to explore socio-demographic and psychosocial factors associated with the intention to prepare for pregnancy in men. Major strengths of this study are the multicenter recruitment and the comprehensive assessment with a validated questionnaire. Although this research extends our knowledge of preconception health behaviors in men, there are several limitations that should be mentioned. First, the pre-test included 6 native men who were all higher educated. As a result, it is possible that some words, items of expression were less readable or too difficult to read and understand to men of lower socio-economic status. Second, the sample consisted of mostly self-selected men, with the exception of the male students who were recruited through secondary schools. In addition, the sample was limited to men who understand written Dutch or English. Consequently, the proportion of men with a foreign nationality (5%) was lower in our study than the proportion in Flanders (11%). Although the proportion of higher educated men (34%) is in line with national average (36%), our sample comprises a high proportion of students (66%). The results are different if we analyze the level of education without the student population: 73% of the men were educated at bachelor's or master's level. Therefore, these findings may be less generalizable to men with foreign nationality and the lower educated non-student male population. Third, although the intention is viewed as primary determinant of behavior, actual behavior would have been a more accurate outcome variable (de Vries et al., 1988; Devries and Backbier, 1994; Lechner and Devries, 1995; De Vries et al., 1998). Fourth, this study has a cross-sectional design, which does not allow determination of the causal direction of the findings. Therefore, future studies should use a longitudinal design to assess whether psychosocial factors and intention have an influence on preconception lifestyle adjustments in men. Fifth, the list of preconception health behaviors was limited to ten, whereof some are

controversial due to limited and conflicting data, such as the impact of environmental testicular hyperthermia on the male fertility (Momen et al., 2010; Rao et al., 2016). More research is needed on other preconception lifestyle changes, including sexual transmitted infection screening and avoiding exposure to environmental toxins. Sixth, preconception behavioral intention and self-efficacy were measured and studied as dichotomous, single-item variables, which is most likely an oversimplification of complex psychosocial constructs. In addition, high odds ratios and broad confidence intervals were observed for the independent variable self-efficacy, which may be due to low cell frequencies in some of the categories. Low cell frequencies were frequently observed in the category of men with low self-efficacy and an affirmative intention to perform a certain preconception health behavior. Therefore, the actual strength of the association between intention and self-efficacy need to be interpreted with caution. Furthermore, preparing for pregnancy was viewed as an overarching construct capturing the different preconception lifestyle behaviors. An overall intention and self-efficacy score was calculated. However, intention and self-efficacy are normally behavior-specific; therefore, these findings must be interpreted cautiously. In addition, the proportion of men who smoked (n= 44), used medication (n= 44), and were overweight or obese (n= 59) was low in our study. As a result, it is possible that certain associations were not detected due to low cell frequencies. Lastly, because of the high number of missing values for the variables income, perceived poverty, and history of fertility treatment, these were not entered in the multiple regression model.

CONCLUSION

Our findings showed that self-efficacy, social influence of the close social environment, attitude towards preparing for pregnancy, and negative emotions and beliefs were psychosocial factors that were associated with the intention to prepare for pregnancy. Based on these findings, several recommendations can be made for future intervention development.

It is recommend to develop an intervention that targets the identified psychosocial factors associated with preconception behavior (intention). In order to develop an effective intervention, it is important to select effective behavior change methods (Kok et al., 2016). A behavior change method is effective if it matches with the determinant that can change the behavior and if it is translated into a practical application that fits with the target population, culture, and context (Kok et al., 2016). The intervention Mapping taxonomy of behavior change methods can be used as a help to select theory-based methods that have been shown to be able to change determinants of behavior. *Modeling* (i.e, the provision of an appropriate model to reinforce the desired behavior) may be one method to support men's self-efficacy to prepare for pregnancy (Kok et al., 2016), and may be translated in the use

of role-model stories including peers that are reinforced for preconception health behaviors. Methods that can be used to change attitude and negative emotions and beliefs about preconception health behaviors are *arguments* (i.e., using meaningful premises and a conclusion) and *cultural similarity* (i.e., using characteristics of the target group in message). Arguments and cultural similarity may be translated in health messages with pictures and language use of target population, suggesting that parenthood starts before conception, and that male health and involvement in the preconception period are important because it can lead to improved pregnancy outcomes. *Information about other's approval* (i.e., provision of information about what other people think about the behavior and whether others will approve or disapprove the behavioral change) can be a method to increase the positive impact of the social influence of the close social environment regarding preconception health behaviors. One application for information about other's approval could be a health message with a conversation between a pregnant woman and her friends, emphasizing and praising the support of her partner and his preconception lifestyle changes.

To date, very few preconception health interventions are focused on men (Toivonen et al., 2017). Further research is needed to explore what are the most appropriate methods and practical applications to target men. The study population in the current study consisted of the general reproductive-aged men with a desire for (more) children. The methods of change and practical translations will depended on the context and characteristics of the target population, such as their age (adolescents versus adults), desire for children (active versus future desire), and culture (Kok et al., 2016).

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REFERENCE LIST

Bartholomew Eldrigde LK, Markham CM, Ruiter RAC, Fernandez ME, Kok G, Parcel GS (2016) Planning health promotion programs: an intervention mapping approach, fourth Edition. Hoboken, NJ: Wiley & Sons.

Bassett-Gunter RL, Levy-Milne R, Naylor PJ, Symons Downs D, Benoit C, Warburton DE, Blanchard CM, Rhodes RE (2013) Oh baby! Motivation for healthy eating during parenthood transitions: a longitudinal examination with a theory of planned behavior perspective. The international journal of behavioral nutrition and physical activity 10:88.

Bodin M, Kall L, Tyden T, Stern J, Drevin J, Larsson M (2017) Exploring men's pregnancy-planning behaviour and fertility knowledge:a survey among fathers in Sweden. Ups J Med Sci 122:127-135.

Campbell JM, Lane M, Owens JA, Bakos HW (2015) Paternal obesity negatively affects male fertility and assisted reproduction outcomes: a systematic review and meta-analysis. Reproductive biomedicine online 31:593-604.

Charafeddine L, El Rafei R, Azizi S, Sinno D, Alamiddine K, Howson CP, Walani SR, Ammar W, Nassar A, Yunis K (2014) Improving awareness of preconception health among adolescents: experience of a school-based intervention in Lebanon. BMC Public Health 14:774.

de Vries H, Dijkstra M, Kuhlman P (1988) Self-efficacy: the third factor besides attitude and subjective norm as a predictor of behavioural intentions. Health education research 3:273-282.

De Vries H, Mudde AN, Dijkstra A, Willemsen MC (1998) Differential beliefs, perceived social influences, and self-efficacy expectations among smokers in various motivational phases. Preventive medicine 27:681-689.

Delbaere I, Mokangi P, Roelens K, De Sutter A, Gellynck X, Beeckman D, van de Walle L, Vandenbulcke P, De Steur H (2016) Systematic development of an evidence-based website on preconception care. Ups J Med Sci:1-7.

Delissaint D, McKyer EL (2011) A systematic review of factors utilized in preconception health behavior research. Health Educ Behav 38:603-616.

Deutsch R, Strack F (2006) Duality models in social psychology: From dual processes to interacting systems. Psychological Inquiry 17: 166-172.

Devries H, Backbier E (1994) Self-efficacy as an important determinant of quitting among pregnant women who smoke: The ø-pattern. Preventive medicine 23:167-174.

Ebel RL (1972) Essentials of Educational Measurement. Oxford, England: Prentice-Hall.

Frankish K (2010). Dual-process and dual-system theories of reasoning. Philosophy Compass 5: 914-926.

Frey KA, Files JA (2006) Preconception healthcare: what women know and believe. Matern Child Health J 10:S73-77.

Frey KA, Engle R, Noble B (2012) Preconception healthcare: what do men know and believe? Journal of Men's Health 9:25-35.

Frey KA, Navarro SM, Kotelchuck M, Lu MC (2008) The clinical content of preconception care: preconception care for men. Am J Obstet Gynecol 199:S389-395.

Fullston T, McPherson NO, Zander-Fox D, Lane M (2017) The most common vices of men can damage fertility and the health of the next generation. The Journal of endocrinology 234:F1-f6.

Goossens J, Beeckman D, Van Hecke A, Verhaeghe S (2018) Socio-demographic and psychosocial factors associated with women's intention to prepare for pregnancy: a cross-sectional study. Submitted for publication, .

Goossens J, Delbaere I, Dhaenens C, Willems L, Van Hecke A, Verhaeghe S, Beeckman D (2016) Preconception-related needs of reproductive-aged women. Midwifery 33:64-72.

Hofmann W, Friese M., Wiers RW (2008) Impulsive versus reflective influences on health behavior: A theoretical framework and empirical review. Health Psychology Review 2: 111-137.

Hood JR, Parker C, Atrash HK (2007) Recommendations to improve preconception health and health care: strategies for implementation. J Womens Health (Larchmt) 16:454-457.

Johnson K, Posner SF, Biermann J, Cordero JF, Atrash HK, Parker CS, Boulet S, Curtis MG (2006) Recommendations to improve preconception health and health care--United States. A report of the CDC/ATSDR Preconception Care Work Group and the Select Panel on Preconception Care. MMWR Recomm Rep 55:1-23.

Kok G, Gottlieb NH, Peters GJY, Mullen PD, Parcel GS, Ruiter RA, Fernández ME, Markham C, Bartholomew L (2016) A taxonomy of behaviour change methods: an Intervention Mapping approach. Health Psychology Review 10:297-312.

La Vignera S, Condorelli RA, Balercia G, Vicari E, Calogero AE (2013) Does alcohol have any effect on male reproductive function? A review of literature. Asian journal of andrology 15:221-225.

Lechner L, Devries H (1995) Starting participation in an employee fitness program: attitudes, social influence, and self-efficacy. Preventive medicine 24:627-633.

Lechner L, de Vries H, Offermans N (1997) Participation in a breast cancer screening program: influence of past behavior and determinants on future screening participation. Preventive medicine 26:473-482.

Lechner L, Oenema A, de Nooijer J (2002) Testicular self-examination (TSE) among Dutch young men aged 15–19: determinants of the intention to practice TSE. Health Education Research 17:73-84.

Masters NT, Morrison DM, Querna K, Casey EA, Beadnell B (2017) Correlates of Young Men's Intention to Discuss Birth Control with Female Partners. Perspectives on sexual and reproductive health 49:37-43.

Mitchell EW, Levis DM, Prue CE (2012) Preconception health: awareness, planning, and communication among a sample of US men and women. Matern Child Health J 16:31-39.

Momen MN, Ananian FB, Fahmy IM, Mostafa T (2010) Effect of high environmental temperature on semen parameters among fertile men. Fertility and sterility 93:1884-1886.

Moos MK, Cefalo RC (1987) Preconceptional health promotion: a focus for obstetric care. Am J Perinatol 4:63-67.

Poels M, Koster MP, Boeije HR, Franx A, van Stel HF (2016) Why Do Women Not Use Preconception Care? A Systematic Review On Barriers And Facilitators. Obstet Gynecol Surv 71:603-612.

Polit DF, Beck CT (2010) Essentials of Nursing Research: Appraising Evidence for Nursing Practice: Wolters Kluwer Health / Lippincott Williams & Wilkins.

Rao M, Xia W, Yang J, Hu LX, Hu SF, Lei H, Wu YQ, Zhu CH (2016) Transient scrotal hyperthermia affects human sperm DNA integrity, sperm apoptosis, and sperm protein expression. Andrology 4:1054-1063.

Ricci E, Al Beitawi S, Cipriani S, Candiani M, Chiaffarino F, Vigano P, Noli S, Parazzini F (2017) Semen quality and alcohol intake: a systematic review and meta-analysis. Reproductive biomedicine online 34:38-47.

Sniehotta FF, Presseau J, Araújo-Soares V (2014) Time to retire the theory of planned behaviour. Taylor & Francis.

Sermondade N et al. (2013) BMI in relation to sperm count: an updated systematic review and collaborative meta-analysis. Human reproduction update 19:221-231.

Streiner DL, Norman GR, Cairney J (2014) Health measurement scales: a practical guide to their development and use: Oxford University Press, USA.

Temel S, Erdem Ö, Voorham T, Bonsel GJ, Steegers E, Denktaş S (2015) Knowledge on preconceptional folic acid supplementation and intention to seek for preconception care among men and women in an urban city: a population-based cross-sectional study. BMC pregnancy and childbirth 15:340-340.

Temel S, Birnie E, Sonneveld HM, Voorham AJ, Bonsel GJ, Steegers EA, Denktas S (2013) Determinants of the intention of preconception care use: lessons from a multi-ethnic urban population in the Netherlands. Int J Public Health 58:295-304.

Toivonen KI, Oinonen KA, Duchene KM (2017) Preconception health behaviours: A scoping review. Preventive medicine 96:1-15.

World Health Organization (2012) Meeting to Develop a Global Consensus on Preconception Care to Reduce Maternal and Childhood Mortality and Morbidity. In. Geneva: World Health Organization Headquarters.

Supplementary data: "PREPARING FOR PREGNANCY" QUESTIONNAIRE

1. Intention and self-efficacy

1. Living a healthy life.
2. Looking for information or advice on how to become pregnant in a healthy way.
3. Eating healthy.
4. Stop smoking.
5. Drinking less alcohol.
6. Losing weight.
7. Avoiding excessive heat to the testicles (e.g., no tight underwear, no warm baths or sauna…).
8. Consulting a healthcare provider on how to become pregnant in a healthy way.
9. Discussing medication or herb use with a health care provider.
10. Supporting my partner in her pre-pregnancy preparations.

2. Attitude

1. I think our chances of having a healthy baby increase as I improve my health prior to a pregnancy
2. I think our chances of having a healthy baby increase as my partner improves her health prior to a pregnancy
3. I think becoming pregnant is a natural process. It does not require any preparations health-wise.
4. I think improving my health prior to a pregnancy is… [unneeded / useful / necessary]

3. Social influence

3.1 Social influence of close social environment

1. I think that I am expected to live a healthy life before my partner gets pregnant.
2. I think that I am expected to support my partner if she improves her health before she becomes pregnant.
3. I think that most people in my close social environment (partner, friends, family, colleagues…) would recommend me to live a healthy life before my partner becomes pregnant.
4. I think that most people in my close social environment would support me if I decide to live a healthy life before my partner becomes pregnant.

3.2 Social norm

5. I think that most men will live healthy/healthier before their partner becomes pregnant.

3.3 Social influence of healthcare provider

6. I think that my GP, gynecologist or medical specialist would recommend me to live a healthy life before my partner becomes pregnant.

3.3 Social influence of media

7. I think that I would feel pressured by the media (TV, newspaper, magazine, radio…) to live a healthy live before my partner becomes pregnant.

3.4 Importance of other's opinion about preconception lifestyle changes

8. How important is the opinion of your (future) partner?
9. How important is the opinion of family?
10. How important is the opinion of friends?
11. How important is the opinion of colleagues or fellow students?
12. How important is the opinion of a GP, gynecologist or medical specialist?

4. Knowledge

1. Smoking 5 cigarettes a day does not have an influence on a woman's fertility.
2. Smoking 5 cigarettes a day does not have an influence on a man's fertility.
3. Quitting alcohol is only needed after a positive pregnancy test.
4. Overweight women have an equal chance of becoming pregnant as women with a normal weight.
5. The age at which a woman becomes pregnant does not have an influence on the unborn child's health
6. All over-the-counter drugs are safe and can be taken by a woman if she plans to become pregnant.
7. If a woman plans to become pregnant, she should avoid eating certain types of fish.
8. Sexually transmitted infections (STDs) should be treated prior to a pregnancy.
9. The best time to start taking folic acid is at the very beginning of the pregnancy.
10. It is recommended to delay pregnancy for a couple of months after a woman decides to stop taking the pill or other hormonal contraceptive.
11. Recreational drugs (e.g. smoking joints) do not have an influence on a woman's fertility.
12. Recreational drugs (e.g. smoking joints) do not have an influence on a man's fertility.
13. Women who are planning to become pregnant and are not immune to toxoplasmosis (= infectious disease), should only eat well-done meat.
14. If a woman wants to become pregnant, she should drink no more than four cups of coffee a day.
15. Getting pregnant immediately after receiving a vaccine against rubella is safe.
16. Vitamin A decreases the risk of having a baby with a cleft lip or spina bifida.
17. At what age is there a decrease in women's ability to become pregnant?

5. Barriers

5.1 health literacy

1. I do not know where to find information.
2. I do not know what I can do to improve my health or fertility.
3. Health advice is often too vague to apply in my life.
4. I find information about health often difficult to understand.

5.2 Emotions and beliefs

5. Reading information about becoming pregnant in a healthy way stresses me out beforehand.
6. I have little control over the health of my unborn child.
7. I think it is mainly the woman's task to become pregnant in a healthy way.
8. I think there are too many rules for becoming pregnant in a healthy way.
9. I do not have the time or energy.

5.3 Religion

10. My religion is a barrier to improve my fertility or health.

5.4 Financial issues

11. I find €10 per month too expensive for e.g. help to stop smoking, advice to improve my fertility.

5.5 Perceived need

12. I find myself healthy enough to reproduce without preparations.

CHAPTER 8

BARRIERS AND FACILITATORS TO THE PROVISION OF PRECONCEPTION CARE BY HEALTH CARE PROVIDERS: A SYSTEMATIC REVIEW

Based on the article of Goossens, J., De Roose, M., Van Hecke, A., Goemaes, R., Verhaeghe, S., Beeckman, D. (2018). Barriers and facilitators to the provision of preconception care by health care providers: a systematic review. International Journal of Nursing Studies. In Press. https://doi.org/10.1016/j.ijnurstu.2018.06.009. Category NURSING: 1/115 (Q1) – IF: 3.66.

ABSTRACT

Background: Health care providers play an important role in providing preconception care to women and men of childbearing age. Yet, the provision of preconception care by health care providers remains low.

Aim: To provide an overview of barriers and facilitators at multiple levels that influence the provision of preconception care by health care providers.

Methods: Five electronic databases were systematically searched up to April 2017. The search strategy contained Medical Subject Headings and key words related to preconception care and health care providers. Reference lists of included studies and systematic reviews on preconception care were screened. Publications were eligible if they reported on barriers and facilitators influencing the provision of preconception care by health care providers. The methodological quality of included studies was evaluated. Barriers and facilitators were organized based on the social ecological model.

Results: Thirty-one articles were included. Barriers were more reported than facilitators. These were situated at provider level (unfavorable attitude and lack of knowledge of preconception care, not working in the field of obstetrics and gynecology, lack of clarity on the responsibility for providing preconception care) and client level (not contacting a health care provider in the preconception stage, negative attitude and lack of knowledge of preconception care). Limited resources (lack of time, tools, guidelines, and reimbursement) were frequently reported at the organizational and societal level.

Conclusions: Health care providers reported more barriers than facilitators to provide preconception care, which might explain why the provision of preconception care is low.

Keywords: 'Preconception Care'; 'Health Personnel'; 'Health Knowledge, Attitudes, Practice'; 'Socio-Ecological Model (SEM)'; 'Review'

Summary of relevance:

Problem: It is unclear which factors have an influence on providing preconception care by health care providers.

What is already known: Health care providers play an important role in the uptake of preconception care. Yet, the provision of preconception care is low and offered on an ad hoc basis. Understanding facilitators and barriers in the provision of preconception care is essential as it can inform intervention strategies to improve preconception health and care.

What this paper adds: This review provides an overview of barriers and facilitators at multiple levels that influence the provision of preconception care by health care providers.

INTRODUCTION

The improvement of maternal health and the reduction of child mortality remain global health objectives, and are two health targets of the Sustainable Development Goals for 2030 that build on the Millennium Development Goals (United Nations, 2015). Despite a substantial reduction of maternal and child mortality between 1990 and 2015, efforts remain necessary to further improve maternal and newborn health, and reduce maternal mortality and preventable deaths of newborns (United Nations, 2015). One strategy towards ending preventable maternal and child mortality could be focusing on preconception care (PCC) as many adverse reproductive outcomes including pregnancy losses, congenital disorders, and low birth weight are associated with preventable preconception risk factors (Johnson et al., 2006; World Health Organization, 2012). Preconception care can be defined as "the provision of biomedical, behavioral and social health interventions to women and couples before conception occurs, aimed at improving maternal and child health outcomes in both the short and long term" (World Health Organization, 2012). PCC is an umbrella term that refers to health promotion, risk assessment, and the initiation of interventions to target risk factors with a potential influence on pregnancy outcomes (Johnson et al., 2006). Key domains of PCC include family planning; nutrition and physical activity; tobacco, alcohol and substance use; occupational and environmental exposures; family history and genetic risks; infectious diseases and immunization; medical and psychosocial conditions; and medications (Johnson et al., 2006). Given the potential benefits of PCC to improve pregnancy outcomes, several prominent international organizations including the Centers for Disease Control and Prevention (CDC), American College of Obstetricians and Gynecologists (ACOG), and World Health Organization (WHO), recommend PCC for all women and men of childbearing age (Johnson et al., 2006; Jack et al., 2008; World Health Organization, 2012). Nevertheless, the use of PCC remains low in couples who are planning a pregnancy (Stephenson et al., 2014). To illustrate, a UK study of Stephenson et al. (2014) found that 63% of the pregnant women with a planned pregnancy reported to take folic acid before pregnancy, and 48% of the smokers and 41% of the drinkers reduced or stopped before conceiving. In addition, research suggests that only 25% to 39% of the couples consulted a health care professional before conception (Poels et al., 2017). A systematic review of Poels et al. (2016) revealed several barriers to women's use of PCC, including lack of awareness and unfamiliarity with the concept of PCC, not fully planning their pregnancy, women's wish for secrecy, perceived absence of risks, and perceived sufficient knowledge. In addition, several provider characteristics were identified as possible influencing factors for PCC use, such as provider attitudes and communication with providers (Poels et al., 2016). This suggests that health care providers (HCPs) may have an important influence on couples' use of PCC. Yet, the provision of PCC by HCPs is low with mainly providing PCC on an opportunistically rather than on a routine basis (Shawe, 2014).

Given the role of HCPs in promoting and providing PCC, an exploration of associated factors and underlying processes of the provision of PCC is needed. Factors influencing the provision of PCC are often complex due to the multifactorial and multilevel character (McLeroy et al., 1988; Bartholomew Eldrigde et al., 2016). Understanding facilitators and barriers to providing PCC is essential as it can inform intervention development and strategies to improve PCC uptake and delivery (Bartholomew Eldrigde et al., 2016). A literature review is one of the first steps in the development of these interventions and strategies (Bartholomew Eldrigde et al., 2016).

To the authors' knowledge, only few systematic reviews were conducted on the topic of PCC, including a literature review on the effectiveness of preconception care (Korenbrot et al., 2002), research regarding preconception health behaviors (Toivonen, 2017), and factors related to the use of preconception care by women (Delissaint and McKyer, 2011; Poels et al., 2016). Curtis et al. (2006) and Steel et al. (2016) performed a systematic review on clinical practice of HCPs with regard to PCC guidelines, and health care professionals' attitudes and experience of preconception care service delivery, respectively. Our study built on this previous work (Curtis et al., 2006; Steel, 2016), and aimed to provide an overview of factors identified as barriers and facilitators at multiple levels that influence the provision of PCC by HCPs.

METHODS

A mixed-methods systematic review was conducted based on PRISMA guidelines.

Search strategy

Five electronic databases were searched up to April 2017: PubMed, Web of Science (WoS), Cumulative Index to Nursing and Allied Health Literature (CINAHL), The Cochrane Library, and Excerpta Medica dataBASE (EMBASE). The search strategy consisted of combining MeSH terms and key words for two concepts: "preconception care" AND "health care provider" (See Table 1). In addition, reference lists of included studies and systematic reviews on preconception care (Curtis et al., 2006; Steel, 2016) were screened to identify additional studies. Authors of relevant conference abstracts were also contacted to identify additional studies.

Table 1. Search strategy with MeSH terms and key words

	OR		OR
MeSH Terms	Preconception Care		Health Personnel Nurses Midwifery General Practitioners Physicians
Key words	Pre conception* Preconception* Prepregnan* Pre pregnancy Pre-pregnancy Periconception* Peri conception* Peri-conception Before pregnancy Internatal* Interpregnan* Inter pregnancy Inter-pregnancy Interconception* Inter conception* Inter-conception Pregestation* Pre gestation* Pre-gestation* Intergestation*	AND	Health Care Provider* Health care Provider* Health care professional* Nurse* Midwife* Midwives Physician* Obstetrician* Gynaecologist* Gynecologist* General practitioner*

Eligibility criteria

Studies written in English, French, German, and Dutch were included if they met the following eligibility criteria: (1) Participants: all health care providers including physicians, midwives, and nurses; (2) Outcomes: perceived barriers and facilitators to provide PCC in general or one aspect of PCC, such as folic acid supplementation or genetic carrier screening; (3) Design: quantitative, qualitative, and mixed methods research. Quantitative studies were excluded if only descriptive statistics were performed. Studies were also excluded if they only focused on barriers and enablers to implementing a nationwide PCC program, because these might be different from factors related to direct care provision.

Study selection

Three reviewers (JG, RG, and MD) independently screened a selection of titles and abstracts. JG screened 11392 titles and abstracts, RG 1000, and MD 773. Differences in assessment were discussed between the reviewers until consensus was reached. In case of disagreement between reviewers, a fourth independent reviewer (DB) was involved. An interrater agreement of 99.7% and 100% between the reviewers (JG and RG on double

screening 1000 articles; JG and MD on double screening 131 articles, respectively) on title and abstract screening was obtained. Two reviewers (JG and MD) both screened the remaining references and full texts.

Quality assessment

To assess the methodological quality of the included studies, we used the Critical Appraisal Skills Programme (CASP) Qualitative checklist developed by the Public Health team in Oxford for qualitative studies, the Quality Assessment Tool developed by Vyncke et al. (2013) for quantitative studies, and the Mixed Methods Appraisal Tool (MMAT) – version 2011 developed by Pluye et al. (2009) for mixed methods studies. The methodological quality was assessed by one reviewer (MD) and 10% of the articles were double checked by a second reviewer (JG). Differences in assessment between the two reviewers were discussed until consensus was reached. Methodological quality was not an exclusion criteria in the review.

Data extraction and synthesis

Data from each study was extracted by two independent reviewers (MD and JG). A data extraction form was used to extract data, which included study aim, content of PCC provision, study design, country and health setting, data collection methods, study population characteristics, and factors associated with providing PCC. The associated factors were classified into barriers (-) and facilitators (+) for the provision of preconception care, and were organized based on the social ecological model (SEM) (McLeroy et al., 1988). The SEM is a theory-based framework for understanding the dynamic and multifaceted interplay between individual and environmental factors that impact behaviors (McLeroy et al., 1988). The SEM acknowledges that individual behavior is shaped through multilevel factors including the individual, interpersonal, organizational, community, and societal level (McLeroy et al., 1988). In the present study we included four levels of influence: provider (individual characteristics and biologically determined factors), client (women's and couples' characteristics, and the characteristics of the provider-client relationship), organizational (policies, formal and informal structures, and rules in health care organizations), and societal (local and national laws and policies). Due to heterogeneity in methodology and content of PCC, results were synthesized descriptively and no meta-analysis was performed.

RESULTS

Selection of articles

A total of 14003 records were identified through database searching. Duplicates (n=1969) were excluded. The remaining articles (n=12034) were screened on title, abstract, and full text respectively, and assessed for

eligibility according to the pre-determined selection criteria (n=117). Twenty-eight articles met all inclusion criteria, and the snowball method added three more articles (Fig. 1).

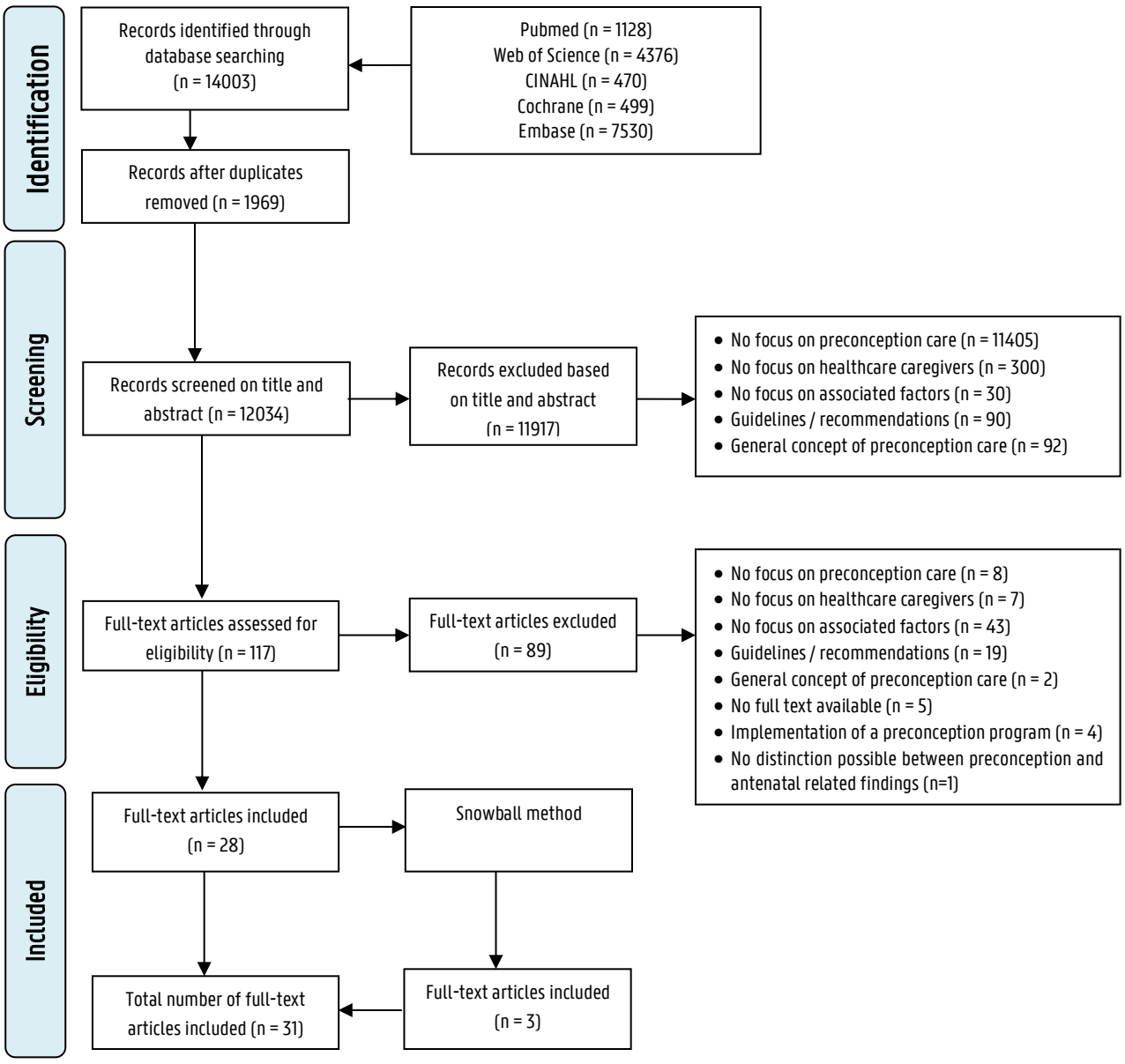

Figure 1. Decision flowchart for identified studies

Study characteristics

Table 2 presents an overview of the study characteristics, barriers and facilitators influencing the provision of PCC.

Table 2. Study characteristics, barriers and facilitators influencing the provision of preconception care

Study	(1) Study aim (2) Content of PCC	Study design	(1) Country (2) Health setting	Data collection methods	Study population Mean ± SD	Factors associated with providing (+) or not providing (-) PCC in relation to level within socio-ecological model
Miranda et al. (2003)	(1) To evaluate the knowledge of primary physicians about FA supplementation for the prevention of NTD (2) PC FA supplementation	Transverse-correlational, quantitative	(1) Puerto Rico (2) One private and one public hospital	Self-administered questionnaire (not validated)	*n*=66 primary physicians; 42.2% female *Age:* 46y ± 9.3 *Years in practice:* /	**Client:** / **Provider:** • Level of knowledge (+ -) **Organizational:** / **Societal:** /
Baars et al. (2004)	(1) To examine the opinion of physicians on PC genetic testing & to examine which factors are associated with a positive opinion (2) PC Cystic fibrosis carrier screening	Cross-sectional, quantitative	(1) the Netherlands (2) General or university hospital	Self-administered validated questionnaire	*n*=497 pediatricians, GPs gynecologists; 28% female *Age:* 68% aged 40-54y *Years in practice:* 14y	**Client:** / **Provider:** • Considering the test sensitivity less important (+) • High perceived risk of having a child with CF (+) • Reassurance when both partners test negative (+) **Organizational:** • Providing genetic counseling in own practice (+) **Societal:** /
Heyes et al. (2004)	(1) To describe the current practice of PCC in Barnsley and to assess the beliefs and attitudes of primary health care practitioners (2) General PCC	Cross-sectional, quantitative	(1) UK (2) Primary care setting	Self-administered questionnaire (not validated), consisting of closed- and open-ended questions	*n*=163 GPs, practice nurses, health visitors and midwives; / *Age:* / *Years in practice:* /	**Client:** • Patient's perception of the importance of PCC (+ -) • Contact with primary care teams after conception (-): unplanned pregnancies (-), no communication about pregnancy plans (-) **Provider:** • Attitude: priority given to PCC (+ -) • Professional responsibility/role: confusion over who should deliver PCC (-) • Lack of training (-) **Organizational:** • Lack of resources (-): money, space, manpower, time • Added workload (-) **Societal:** • Need for evidence-based guidelines • Need for patient information
Morgan et al. (2004)	(1) To assess practices of ObGyns regarding carrier screening for Cystic Fibrosis (2) PC cystic fibrosis carrier screening	Cross-sectional, quantitative	(1) USA (2) ObGyn practices	Self-administered questionnaire (not validated)	*n*=632 ObGyns; 42.4% female *Age:*47.1y ± 0.39 *Years in practice:* / *Years since residency*: 15.4y ± 0.38	**Client:** • Attempting pregnancy (+) (descriptive result) • Health status: family history of CF, having partner who has CF or is known carrier (+) (descriptive result) • Patient request (descriptive result) **Provider:** • More experience (+) • Profession/specialty: ObGyns > Gyns Only (+)

						Organizational: / **Societal:** /
Poppelaars et al. (2004)	(1) To determine the attitudes of potential providers towards PC cystic fibrosis carrier screening (2) PC cystic fibrosis carrier screening	Cross-sectional, quantitative	(1) the Netherlands (2) Community Health Service (CHS), General practice	Self-administered questionnaire (not validated)	*n*=215 GPs and CHS workers; 43% female *Age:* 45y (29–63) *Years in practice: /*	**Client:** / **Provider:** • High perceived severity of cystic fibrosis (+) • being nonreligious compared to reformed (+) • Low perceived barriers (+) • High perceived test sensitivity (+) **Organizational:** / **Societal:** /
Tough et al. (2004)	(1) To describe characteristics of physicians who recommend alcohol abstinence during pregnancy with regard to knowledge of FAS and PC counseling strategies (2) PC alcohol abstinence	Cross-sectional, quantitative	(1) Canada (2) Family practice, obstetrics/ gynaecology practices, midwifery nationwide	Self-administered questionnaire (not validated)	*n*=1090 ObGyns, family physicians and midwives; 51,8% female *Age: /* *Years in practice: /*	**Client:** • Perceived lack of patient interest (-) • Believing that clients are interested in discussing alcohol use (+) **Provider:** • Profession/speciality: FamPhys (+) > midwives and obstetricians • Role: believing in having a role to manage patients in the area of alcohol use (+ -) • Knowledge (+) • Obtaining information from medical journals (+) • Awareness: believing that there is solid information about alcohol use (+) **Organizational:** / **Societal:** /
Morgan et al. (2006)	(1) To describe ObGyns' opinions of PCC (2) PCC in general	Cross-sectional, quantitative	(1) USA (2) ObGyn practices	Self-administered questionnaire (not validated)	*n*=579 ObGyns; 46.1% female Age: 47.3y ± 0.39 *Years in practice:* 15.22y ± 0.41	**Client:** • Frequency with which patients reportedly present for PCC (+) **Provider:** • Opinions regarding PCC: defining PCC as routine (+) ⇔ defining PCC as specialized (-), agree that PCC is important/ positive/ high priority (+) **Organizational:** / **Societal:** /
Tough et al. (2006)	(1) To determine the PC practices among ObGyns and family physicians in Canada (2) General PCC	Cross-sectional, quantitative	(1) Canada (2) Family practice, obstetrics & gynecology nationwide	Self-administered questionnaire (not validated)	*n*=965 family physicians & ObGyns; 50.6% female *Years in practice: /* *Years graduated: ≥22y: 27.4%, 12 – 21y: 31.6%, ≤11 y: 41.0%*	**Client:** / **Provider:** • Profession/speciality: ObGyns (+) > FamPhys for discussing Pap testing & pregnancy related issues including folic acid, smoking, drug use, sexual abuse); FamPhys > ObGyns to discuss mental health, depression, workplace stress

						• Gender: female (+) > male physicians to discuss 9 or more PC and health promotion topics **Organizational:** / **Societal:** /
Williams et al. (2006)	(1) To assess health care providers knowledge and practices regarding FA use for neural tube defect prevention (2) PC FA use	Cross-sectional, quantitative	(1) USA (2) ObGyn and Fam/Gen practice settings	Telephone survey (not validated)	*n*=1111 physicians (ObGyns and Fam/Gen) and non-physicians (physician assistants, nurse practitioner, certified nurse midwives and registered nurses); 60% female *Age:* 76% <55y *Years in practice:* 39% over 20y in practice	**Client**: / **Provider:** • Profession/speciality: providers in ObGyn settings (+) > Fam/Gen settings; nurse practitioners in ObGyn setting (+) were most likely to talk about FA and fam/gen physicians least likely • Provider personally took multivitamin (+) • Lower income clients (+) • Practices consisted of at least 10% minorities (+) • Gender: female provider (+) **Organizational:** / **Societal:** /
Tough et al. (2007)	(1) To examine if physician knowledge and practices related to FASD and its prevention vary based on the proportion of Native/ Aboriginal patients served (2) PC FASD prevention	Cross-sectional, quantitative	(1) Canada (2) Family practice, ObGyn practices, paediatrics nationwide	Self-administered questionnaire (not validated)	*n*=1700 ObGyns, family physicians, paediatrician; / *Age:* / *Years in practice:* /	**Client**: • Ethnicity (+ -): physicians caring for a greater proportion of Native/Aboriginal patients were less likely to discuss folic acid, but more likely to routinely inquire about drinking prior to pregnancy awareness **Provider:** / **Organizational:** • Lack of time (-) (descriptive result) • Poorly formatted information (-) (descriptive result) **Societal**: /
Abu-Hammad et al. (2008)	(1) To evaluate primary care physicians' knowledge and attitudes regarding FA supplementation for childbearing women (2) PC FA supplementation	Cross-sectional, quantitative	(1) Israel (2) The largest health care provider organization in Israel	Self-administered questionnaire (not validated)	*n*=87 primary care physicians; 61.5% *Age:* 47.3y ±7.8y *Years in practice:* 18.7y ±8.7	**Client**: • Ethnicity: Jewish > Bedouin (+ -) **Provider:** • Certification: uncertified > board-certified (+ -) **Organizational:**/ **Societal:** /
McClaren et al. (2008)	(1) To explore perspectives of the Victorian community regarding carrier screening for cystic fibrosis prior to offering screening (2) PC genetic carrier screening for cystic fibrosis	Cross-sectional, qualitative	(1) Australia (2) GPs of practices in the local metropolitan Melbourne area, hospital, prenatal clinics, University of Melbourne	Semi-structured focus group interviews & individual interviews	*n*=12 health providers (midwives, social worker physiotherapists, genetic counsellor, obstetricians GPs); / *Age:* / *Years in practice:* /	**Client**: • The potential psychosocial impact for patients: stigma and stress on relationships (-) • Not thinking about having children (-) **Provider:** • Personal attitude towards offering carrier screening to patients (+ -)

						• Having experience with discussing potential impact and acceptability of a screening programme for their patients (+) **Organizational:** • Time constraints already present in consultations (-) **Societal:** /
Tough et al. (2008)	(1) To determine whether differences exist between rural and urban health care providers in knowledge of, attitudes about and awareness of FASD disorders and PC counseling (2) FASD prevention	Cross-sectional, quantitative	(1) Canada (2) Family practice, obstetrics & gynecology, pediatrics, psychiatry, midwifery nationwide	Self-administered questionnaire (not validated)	*n*=2101 ObGyns, family physicians, psychiatrists pediatricians, midwives; 49.0% female *Age:* <40y: 31%, 40-49y: 34%, 50-57y: 25%, ≥60y: 10% *Years in practice:* / *Years graduated:* ≥42y: 2%; 22–41y: 39%; 12–21y: 31%; ≤11y: 28%	**Client:** / **Provider:** • Belief that clients already had good information on alcohol use (-) (descriptive result) Profession/specialty: urban providers were more likely to discuss folic acid (+) > rural providers; no differences regarding other PC topics **Organizational:** • Lack of time (-) (descriptive result) • Information not in a useful format (-) (descriptive result) **Societal**: /
Schwarz et al. (2009)	(1) To identify what primary care providers perceive as barriers to and potential facilitators of providing counseling to women of childbearing age when teratogenic medications are prescribed (2) Teratogenic medications	Cross-sectional, qualitative	(1) USA (2) 4 clinical settings in Pittsburgh, Pennsylvania	Focus group interviews	*n*=48 primary care providers (academic and community-based clinicians, pharmacists, nurses, physicians, clinical faculty and trainees); 88% female *Age:* 49y ± 9 *Years in practice.* /	**Client:** • Concern that patient anxiety related to information about teratogenic risk will lead to medication non-use (-) • Women having difficulty of volunteering information about their pregnancy intention (-) **Provider:** • Professional responsibility/role (+) • Difficulty identifying patients' pregnancy intentions / not routinely asking patients' pregnancy intentions (-) **Organizational:** • Limited clinical time & competing medical priorities. Discussions about teratogenic risks of medication are complex and time consuming (-) • Difficulty finding clinically relevant information on medications' teratogenicity (-) • Assistance in identifying medications that pose teratogenic risks (+) (e.g. online references, computerized decision support) • Assistance in identifying women's pregnancy intentions (+) **Societal:** • Lack of reimbursement for time spent counseling (-) • Access to educational materials for patients (+)
Bonham et al. (2010)	(1) To assess the influence of patient characteristics on decisions to offer preconception genetic screening	Cross-sectional, quantitative	(1) USA (2) General practice	Self-administered questionnaire (not validated)	*n*=968 family physicians; 32.7% female *Age:* 45.6y	**Client:** • Race: being black (+) • Female gender (+) (black patient)

	(2) PC genetic screening				*Years in practice: /* *Years since residency completion*: <5y: 19%, 5y-15y: 36%, >15y: 45%	• Age (+) (descriptive result) **Provider:** • Work experience: completing residency less than 15 years earlier (+) (black patient) • Working in a university, teaching, or residency training environment (+) (black patient) **Organizational:** / **Societal:** /
Parker et al. (2010)	(1) To assess perceptions of the importance of PCC and factors affecting the willingness of STD counselors to integrate PCC in STD clinics. (2) General PCC	Cross-sectional, quantitative	(1) USA (2) STD clinics	Self-administered questionnaire (not validated)	*n*=140 STD counselors; / Age: / *Years in practice:* 2-5y: 21%, 6-10y: 48%, ≥ 10y: 31%	**Client:** / **Provider:** • Good or excellent knowledge of PCC (+) • Higher level of responsibility (+) • More years of work experience (+) • Coming from areas with high levels of morbidity (+) **Organizational:** / **Societal:** /
Mortagy et al. (2010)	(1) To explore the perspective of GPs and secondary care health professionals on the role of GPs in delivering PC to women with diabetes (2) General PC to women with diabetes	Cross-sectional, qualitative	(1) UK (2) Diverse set of GP practices and 1 London teaching hospital	Semi-structured interviews	*n*=15 GPs and secondary health care professionals; / *Age*: / *Years in practice*: /	**Client:** / **Provider:** • Interest in diabetes care (+) • Professional responsibility/role: lack of a defined GP role in PCC (-) • Awareness through ongoing education and training (+) **Organizational:** • Lack of clear division of responsibility and -labor regarding diabetes care practices between primary and secondary care (-) • Practice protocols regarding PCC (+) **Societal:** • Lack of clear guidelines on how to provide PCC and when to make referrals (-) • Evidence-based information on PC benefits (+) • Access to patient information leaflets (+)
Burris et al. (2011)	(1)To determine whether medical providers order folic acid or folic acid-containing multivitamins for their non-pregnant female patients of childbearing age (2) PC FA and multivitamins	Cross-sectional, quantitative	(1) USA (2) Non-federally office based physician practice and non-federal hospitals	Analysis of data from two data sources NAMCS and NHAMCS	*n*=4634 preventive visits of non-pregnant women *Age: /* *Years in practice: /*	**Client:** • Age (+); women ages 30-34 > women aged 15-19 or 40-44 • Race/ethnicity (+): race other than white, black or Hispanic • Insurance status (+): Medicaid > private insurance or other **Provider:** • Profession/specialty: (+): ObGyns > non-ObGyns **Organizational:** / **Societal:** /

Chuang et al. (2012)	(1) To examine primary care physicians' perceptions of barriers to preventive reproductive health care (2) General PCC	Cross-sectional, qualitative	(1) USA (2) Solo private practices and hospital-owned multispecialty groups in rural central Pennsylvania	Semi-structured telephone and face-to-face interviews	*n*=19 rural primary care physicians; 47.4% female *Age:/* *Years in practice:* 21y (1–38)	**Client** • Not initiating discussions about pregnancy planning because of indifference to family planning (-) **Provider:** • Professional responsibility/role: belief that it is not the primary care physician's role to initiate and discuss pregnancy planning and PCC (-) • PCC is no priority (-) • Feeling uncertain what they could offer (-) **Organizational** • Lack of time (-) • A lack of local specialists: lack of access to obstetricians with training in managing high-risk pregnancies who may assist PCC, or endocrinologists who may assist with management of diabetes (-) **Societal** • Rural community norms (-): e.g. accepting unintended pregnancies, early childbearing, large families…
Mazza et al. (2013)	(1) To examine the barriers and enablers to the delivery and uptake of PCC guidelines from GPs' perspective using theoretical domains related to behavior change (2) General PCC	Cross-sectional, qualitative	(1) Australia (2) Diverse practice settings	Focus group interviews	n=22 GPs; 59.1% female *Age:/* *Years in practice:/*	**Client:** • Not presenting at PC stage (-): unaware of availability and importance of PCC (-) • Not willing to spend more time and money for multiple consultations (-) **Provider:** • Perception of having no opportunity to deliver PCC (-) • Beliefs about effectiveness PCC: doubts regarding effectiveness of folic acid in preventing NTD's (-) • Other competing preventive care priorities (believing in a potential increase in burden on clinics if the number of PCC consultations was increased (-) **Organizational:** • Time limits on consultation (-) • GP and patient resources for PCC: Lack of resources (-); availability of PCC resources (e.g. checklists/ patient brochures/ handouts/ waiting room posters) (+) • Limited access to individual GPs (e.g. long waiting list) (-) • Limited number of GPs willing to deliver PCC (-): potential delay for patients • Potential burden on clinics if PCC consultations increased (-) **Societal:** • Lack of GP & patient resources (e.g. evidence based websites) for PCC (-)

Power et al. (2013)	(1) To assess barriers to and quality of preconception, prenatal and postnatal care for diabetic women by obstetrician-gynecologists (2) General PCC	Cross-sectional, quantitative	(1) USA (2) Private group, private solo, academic, hospital-owned settings	Self-administered questionnaire (not validated)	*n*=510 ObGyns, / *Age: /* *Years in practice*: 17.5 ± 1.5 y.	**Client**: ● Health status: if a patient had diabetes, physicians were more likely to ask about pregnancy plans (+) (descriptive result) ● Active desire for children (+) (descriptive result) **Provider**: • Profession/specialty: Maternal-fetal medicine specialist (+) > non-Maternal-fetal medicine specialist **Organizational**: / **Societal**: /
Stephenson et al. (2014)	(1) To assess the views and engagement of health professionals with PCC (2) General PCC	Cross-sectional, qualitative	(1) UK (2) All settings related to general practice, obstetrics & gynecology, midwifery, sexual & reproductive health	Telephone interviews	*n*=21 consultants in ObGyn, midwives, GPs, community based consultants (or clinical leads) in sexual and reproductive health, sexual health specialist nurse; / *Age:* <30y: 28%, 30-34y: 41%, 35+y: 31% *Years in practice: /*	**Client:** ● Unplanned pregnancies (-) ● Awareness (+) **Provider:** ● Professional responsibility/role: PCC is someone else's responsibility (-) ● Knowledge (+ -) ● Confidence (+) ● Lack of interest (-) **Organizational:** / **Societal:** ● Constrained resources (-) ● Financial incentives for delivery of PCC (+)
Archibald et al. (2016)	(1) To explore stakeholder views about offering population-based genetic carrier screening for fragile X syndrome (2) PC genetic carrier screening for fragile X syndrome	Cross-sectional, qualitative	(1) Australia (2) /	Semi-structured interviews & focus groups	*n*=81 health providers (GPs, physiotherapists nurses, midwives, speech pathologists, ObGyns, psychologists, support workers, pediatricians, clinical geneticists and counselors, medical scientists, occupational therapists); / *Age: /* *Years in practice: /*	**Client:** ● Lack of knowledge and awareness (-) ● The potential to increase anxiety at a stressful time (-) **Provider:** ● Lack of knowledge and awareness (-) ● Support from health care providers (+) **Organizational:** ● Reduced time for decision-making (-) ● Limited reproductive options (-) ● Limited time available to provide pretest counseling (-) ● A selective approach to offering screening (-) ● Trained and qualified care providers to offer the test (+) ● Sufficient resources for managing test-positive results (+) **Societal:** ● Development of protocols and guidelines (+) ● Economic evaluations (+)

Coll et al. (2016)	(1) Exploring knowledge, attitude and practices among health care providers regarding PCC, safer conception and pregnancy among HIV-infected women (2) PCC among HIV-infected women	Cross-sectional, qualitative	(1) USA (2) Urban South Florida – public and private hospitals	Key informant interviews	*n*=14 nurse practitioners physicians, physician assistants, and providing ObGyn and HIV care; / *Age: /* *Years in practice: /*	**Client:** • Lack of knowledge (-) • Women do not bring up the topic due to stigmas surround HIV-infected women's desires for children (-) and unplanned pregnancy (-) **Provider:** • Competing medical priorities (-) • Failure to address fertility desires (-) • Limited knowledge/understanding of PC issues (-) **Organizational:** • Time constraints (-) • Lack of provider resources for HIV-infected women (-) **Societal:** /
McPhie et al. (2016)	(1) To identify barriers to providing preconception weight management (2) PC weight management	Cross-sectional, qualitative	(1) Australia (2) /	Semi-structured phone interview	*n=20* health providers with expertise in maternal and child health (primary health practitioners, midwives, stakeholders working in health policy, health care management, preventive health); / *Age: /* *Years in practice: /*	**Client:** • Lack of awareness of the importance of PC health and weight: especially women who are not planning on becoming pregnant (-) • Unplanned pregnancies (-) **Provider:** • Professional responsibility/role: conflicting ideas about who should be responsible for providing PCC (-) • Sensitive nature of the topic (-) • Lack of confidence to handle sensitive conversations (-) • Limited access to women of childbearing age who plan to conceive: misconception about prevalence of unplanned pregnancies and impossible to determine which women will become pregnant and when (-) **Organizational:** • No scope in their role or the current health care system (e.g. due to time constraints) (-) **Societal:** • No scope in their role or the current health care system (e.g. due to time constraints) (-)
Ojukwu et al. (2016)	(1) To examine GPs knowledge, attitudes, and views towards preconception health and care in the general practice setting (2) General PCC	Cross-sectional, qualitative	(1) UK (2) General practices	Individual semi-structured interviews	N=7 GPs; 42.8% female *Age: /* *years in practice: 13.7y*	**Client:** • Lack of attendance for health care before pregnancy (-): unplanned pregnancies, ethnic populations • Lack of knowledge (-) • Lack of perceived need (-) **Provider:** • Lack of motivation (-)

						• 'Nanny state' indicating personal behavior (-) **Organizational:** • Lack of time (-) • Financial constraints (-) **Societal**: /
van Voorst et al. (2016)	(1) To assess current activities, perceptions and prerequisites for delivery of PCC (2) General PCC	Cross-sectional, quantitative	(1) the Netherlands (2) primary care setting	Self-administered questionnaire (not validated)	*n*=699 GPs and midwives; 69.6% female *Age*: 41y (23–66) *Years in practice:* /	**Client**: • Mentioning desire to become pregnant (+) (descriptive result) • After miscarriage (+) (descriptive result) • Apparent risk for adverse reproductive outcomes (+) (descriptive result) • Postnatal check-up (+) (midwives – descriptive result) • Prescription medication, discussing contraception and follow-up chronic disease (+) (GPs – descriptive result) **Provider :** • Profession/specialty: GPs (+) > midwives in performing PCC consultation; midwives > GPs in assessing PCC risk factors • Perceptions (-): PCC only for women with high risks, PCC medicalised preconception period, PCC without women asking for it was objectionable (descriptive results) **Organizational**: / **Societal**: /
Fieldwick et al. (2017)	(1) To explore the knowledge and practice of GPs regarding PC and gestational weight management (2) PC weight management (in women having overweight, obesity or women who excess gestational weight gain)	Cross-sectional, mixed methods	(1) New Zealand (2) /	Self-administered questionnaire (not validated), consisting of closed-ended questions (quantitative) and an open question (qualitative)	*n*= 200 GPs; / *Age:* <30y: 2%, 30-39y: 26%, 40-49y: 23%, 50-59y: 35%, 60+y: 15% *Years in practice:* <4y: 11%, 4-9y: 20%, 10-15y: 17%, >15y: 52%	**Client**: • Health status: GPs more often discuss weight management with overweight or obese women (+) (descriptive result); if women present preconception, it is often related to infertility (+) • Rarely presenting for PCC (-) **Provider:** • Lack of opportunity to provide PCC (-) • Lack of awareness: not knowing what PCC involves and the benefits of PC interventions in overweight and obese women (-) **Organizational:** / **Societal:** /
M'hamdi et al. (2017)	(1) To examine health care professionals' views of their role and responsibilities in providing PCC and identify barriers that affect the delivery and uptake of PCC (2) General PCC	Cross-sectional, qualitative	(1) The Netherlands (2) One university hospital (specialists), GP and midwifery practices	Semi-structured interviews	*n*=20 midwives, GPs, specialists; / *Age:* / *Years in practice:* /	**Client**: • Unfamiliarity with PCC (-) • Limited awareness about importance of PCC (-) • Low socioeconomic women are hardest to reach (-) • Not willing to invest time and effort (-) **Provider:** • Unfamiliarity with PCC (-)

						• Lack of knowledge of PCC (-) • Ethical barriers (-): tension between personal beliefs about pregnancy and the wellbeing of the future child on the one hand ⇔ the professional responsibility to provide the best care possible for patients while respecting the reproductive autonomy of the future parents on the other hand **Organizational:** • Time consuming (-): PCC is a new form of care, a substantial amount of risk factors should be addressed, competing preventive care which also needs to be delivered • Poor or lack of communication between different health care disciplines that offer PCC (-) **Societal:** • No financial compensation (-): lack of a fee in combination with labor intensiveness
Poels et al. (2017)	(1) To identify bottlenecks and solutions for the delivery of PCC from a HC providers' perspective (2) General PCC	Cross-sectional, qualitative	(1) The Netherlands (2) /	Parallel group sessions	*n*=30 health providers (gynecologists, midwives, preventive child health care, fertility specialists, maternity care, GPs, dietician, physiotherapists, patient advocacy, municipal policy officer; / *Age:* / *Years in practice:* /	**Client:** • Lack of attendance for health care before pregnancy due to unawareness (-) and poor understanding of personal risks (-) • High-risk groups (low socioeconomic status, non-western ethnicity or living in deprived areas) due to ignorance, lack of self-knowledge and inadmissibility for PC information (-) **Provider:** • Role/responsibility: unclear who should be the entitled provider for PCC (-) • Profession/specialty: midwives less access to women with childbearing plans, but most willing to provide PCC; GPs have more access to women with childbearing plans, but less interested in providing PCC • Lack of awareness and knowledge (-) • Not being convinced of the importance, need, benefits and efficacy of PCC (-) • Lack of experience (-) **Organizational:** • Role/responsibility: unclear who should be the entitled provider for PCC (-) • PCC consults are time consuming (time constraints) (-) • Limited collaboration and referrals between health care providers with regard to PCC due to lack of awareness of PCC and existing tension between different health care disciplines (-) **Societal:**

						• Lack of tools/guidelines for PCC (-) • Lack of overview of collaboration partners (-) • Education: formal professional education on PCC falls short (midwives) (-) • Absence of a costing structure (financial constraints) (-)
Bortolus et al. (2017)	(1) To investigate attitudes and behaviors of Italian women of childbearing age and health care professionals regarding preconception health (2) General PCC	Cross-sectional, qualitative	(1) Italy (2) Hospital setting	Focus group interviews	*n*=12 health providers with expertise in a mother and child health field (neonatal nurses, hospital midwives, ObGyns, pediatrician); 100% female *Age:* 38.4y (29-52) *Years in practice:* 13.9y (4-32)	**Client:** • Not initiating discussions about preconception health (-) **Provider:** • Role/responsibility: unclear who should be the entitled provider for PCC (-) **Organizational:** • PCC consults are time consuming (time constraints) (-) **Societal: /**

Abbreviations: PC: preconception; PCC: preconception care; CF: cystic fibrosis; FA: folic acid; fam/gen: family/general; FamPhys; family physician; FAS: fetal alcohol syndrome; FASD: fetal alcohol spectrum disorders; GP: general practitioner; NTD: neural tube defects; ObGyns: obstetrician-gynecologists; STD: sexually transmitted diseases.

All included research articles (n = 31) were published in English between 2003 and 2017. This review discussed 17 quantitative studies including 16 cross-sectional study designs (Baars, 2004; Heyes, 2004; Morgan, 2004; Poppelaars, 2004; Tough, 2004; Morgan et al., 2006; Tough, 2006; Williams, 2006; Tough, 2007; Abu-Hammad, 2008; Tough, 2008; Bonham, 2010; Parker, 2010; Burris, 2011; Power, 2013; van Voorst, 2016), and one transverse correlational study design (Miranda, 2003); 13 qualitative studies (McClaren, 2008; Schwarz, 2009; Mortagy, 2010; Chuang, 2012; Mazza, 2013; Stephenson et al., 2014; Archibald, 2016; Coll, 2016; McPhie, 2016; Ojukwu, 2016; Bortolus, 2017; M'Hamdi, 2017; Poels, 2017); and one mixed method design (Fieldwick, 2017). The studies were conducted in a variety of settings, including general / university / public / private hospitals, private practices, and primary care settings in the field of obstetrics and gynecology, pediatrics, midwifery, and family practice in particular. The majority of the studies were conducted in the USA (n = 10) (Morgan, 2004; Morgan et al., 2006; Williams, 2006; Schwarz, 2009; Bonham, 2010; Parker, 2010; Burris, 2011; Chuang, 2012; Power, 2013; Coll, 2016), the Netherlands (n = 5) (Baars, 2004; Poppelaars, 2004; van Voorst, 2016; M'Hamdi, 2017; Poels, 2017), Canada (n = 4) (Tough, 2004; Tough, 2006; Tough, 2007; Tough, 2008), the UK (n = 4) (Heyes, 2004; Mortagy, 2010; Stephenson et al., 2014; Ojukwu, 2016), and Australia (n = 4) (McClaren, 2008; Mazza, 2013; Archibald, 2016; McPhie, 2016). Sample size, referring to the total number of health care providers included, ranged from small-scale studies (n = 7) to large-scale studies (n = 2101).

Thirteen publications focused on general PCC (Heyes, 2004; Morgan et al., 2006; Tough, 2006; Parker, 2010; Chuang, 2012; Mazza, 2013; Power, 2013; Stephenson et al., 2014; Ojukwu, 2016; van Voorst, 2016; Bortolus, 2017; M'Hamdi, 2017; Poels, 2017), six studies on preconception genetic screening (e.g. cystic fibrosis carrier screening, fragile X syndrome) (Baars, 2004; Morgan, 2004; Poppelaars, 2004; McClaren, 2008; Bonham, 2010; Archibald, 2016), four studies on preconception folic acid supplementation (and multivitamins) (Miranda, 2003; Williams, 2006; Abu-Hammad, 2008; Burris, 2011), three studies on preconception alcohol use (e.g. abstinence, fetal alcohol spectrum disorder prevention) (Tough, 2004; Williams, 2006; Tough, 2007; Tough, 2008), one study on weight management (McPhie, 2016), and one study on teratogenic medications (Schwarz, 2009). Few publications focused on PCC in specific subpopulations e.g. women with diabetes (n = 1) (Mortagy, 2010), HIV-infected women (n = 1) (Coll, 2016), and women suffering from overweight or obesity (n = 1) (Fieldwick, 2017).

Methodological quality of the studies included

A summary of the quality assessment of the included quantitative studies is displayed in Table 3, in Table 4 for studies with a qualitative approach, and in Table 5 for mixed methods studies. In general, the overall methodological quality of the quantitative studies was weak to moderate. A considerable risk of selection bias was present in half of these studies. Five studies mentioned the potential influence of confounding factors

(Baars, 2004; Tough, 2004; Morgan et al., 2006; Bonham, 2010; Burris, 2011). Data collection methods were evaluated as moderately valid and/or reliable in only two studies (Miranda, 2003; Baars, 2004). Few studies reported on power calculation (n = 4), and nine articles did not report on how they handled missing data (Miranda, 2003; Baars, 2004; Heyes, 2004; Morgan, 2004; Poppelaars, 2004; Morgan et al., 2006; Tough, 2007; Power, 2013; van Voorst, 2016). However, in all studies, the main results of statistical analysis were unambiguously reported, the statistical methods were appropriate, and the results-section reported on all outcomes measures mentioned in the method-section.

With regard to the qualitative studies, the articles generally showed good methodological quality. All qualitative studies had a clear statement of aims, an appropriate methodology and data collection, an appropriate recruitment strategy, a clear statement of findings, and were considered to be valuable research. Nevertheless, in one study (McPhie, 2016), the presence of an appropriate design could not be evaluated. Three articles did not sufficiently report on rigorousness of the data analysis (McClaren, 2008; Stephenson et al., 2014; Bortolus, 2017). Only two research articles clearly considered the relationship between the researcher and the participants (McPhie, 2016; Poels, 2017). Ethical issues were inadequately discussed in four qualitative studies (McClaren, 2008; Mortagy, 2010; Chuang, 2012; Stephenson et al., 2014).

One article with a relevant mixed method design, integrating both qualitative and quantitative data, was included (Fieldwick, 2017). Nevertheless, the study inappropriately considered the limitations of this integration. The qualitative part was based on relevant data sources, and an adequate data analysis process. The relation between the findings and the context as well as the researchers' influence were, however, inadequately considered. The quantitative part was characterized by inappropriate measurements, and the absence of an acceptable response rate. The sampling strategy was found to be relevant, and the presence of a representative sample could not be evaluated.

Table 3. Summary of the quality assessment of the included quantitative studies using the Quality Assessment Tool (QAT) for Quantitative Studies

	Selection bias	Allocation bias	Confounders	Data collection methods	Withdrawals & drop-out	Analysis					
						Q1[a]	Q2[b]	Q3[c]	Q4[d]	Q5[e]	Q6[f]
Miranda et al. 2003	Weak	Moderate	Weak	Moderate	NA	No	Yes	Yes	Yes	NR	Yes
Baars et al. 2004	Moderate	Moderate	Strong	Moderate	NA	No	Yes	Yes	Yes	NR	Yes
Heyes et al. 2004	Moderate	Moderate	Weak	Weak	NA	No	Partially	Yes	Yes	NR	Yes
Morgan et al. 2004	Moderate	Moderate	Weak	Weak	NA	Yes	Yes	Yes	Yes	NR	Yes
Poppelaars et al. 2004	Moderate	Moderate	Weak	Weak	NA	No	Yes	Yes	Yes	NR	Yes
Tough et al. 2004	Weak	Moderate	Strong	Weak	NA	No	Yes	Yes	Yes	Yes	Yes
Morgan et al. 2006	Moderate	Moderate	Strong	Weak	NA	Yes	Yes	Yes	Yes	NR	Yes
Tough et al. 2006	Weak	Moderate	Weak	Weak	NA	Yes	Yes	Yes	Yes	Yes	Yes
Williams et al. 2006	Moderate	Moderate	Weak	Weak	NA	No	Yes	Yes	Yes	Yes	Yes
Tough et al. 2007	Weak	Moderate	Weak	Weak	NA	No	No	Yes	Yes	NR	Yes
Abu-Hammad et al. 2008	Weak	Moderate	Weak	Weak	NA	No	Yes	Yes	Yes	Yes	Yes
Tough et al. 2008	Weak	Moderate	Weak	Weak	NA	Yes	Yes	Yes	Yes	Yes	Yes
Bonham et al. 2010	Weak	Moderate	Moderate	Weak	NA	No	Yes	Yes	Yes	Yes	Yes
Parker et al. 2010	Moderate	Moderate	Weak	Weak	NA	No	Yes	Yes	Yes	Yes	Yes
Burris et al. 2011	Moderate	Moderate	Strong	Weak	NA	No	Yes	Yes	Yes	Yes	Yes
Power et al. 2013	Weak	Moderate	Weak	Weak	NA	No	Partially	Yes	Yes	NR	Yes
van Voorst et al. 2016	Weak	Moderate	Weak	Weak	NA	No	Yes	Yes	Yes	No	Yes

[a]Sample size or power calculation; [b]Characteristics of study participants extensively described; [c]Main results of statistical analysis unambiguously reported; [d]Statistical methods appropriate; [e]Missing data handled in an appropriate way; [f]Results-section report on all outcome measured mentioned in the method-section; NA, Not applicable; NR, Not reported.

Table 4. Summary of the quality assessment of the included qualitative studies using the Critical Appraisal Skills Programme (CASP) for Qualitative Studies

	Clear statement of aims	Appropriate methodology	Appropriate design	Appropriate recruitment strategy	Appropriate data collection	Adequate consideration relationship researcher - participants	Consideration ethical issues	Rigorousness data analysis	Clear statement of findings	Valuability study
McClaren et al. 2008	Yes	Yes	Yes	Yes	Yes	Can't tell	No	No	Yes	Valuable
Schwarz et al. 2009	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable
Mortagy et al. 2010	Yes	Yes	Yes	Yes	Yes	Can't tell	Can't tell	Yes	Yes	Valuable
Chuang et al. 2012	Yes	Yes	Yes	Yes	Yes	Can't tell	Can't tell	Yes	Yes	Valuable
Mazza et al. 2013	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable
Stephenson et al. 2014	Yes	Yes	Yes	Yes	Yes	Can't tell	Can't tell	No	Yes	Valuable
Archibald et al. 2016	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable
Coll et al. 2016	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable
McPhie et al. 2016	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes	Valuable
Ojukwu et al. 2016	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable
M'hamdi et al. 2017	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Valuable
Poels et al. 2017	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Valuable
Bortolus et al. 2017	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	No	Yes	Valuable

Table 5. Summary of the quality assessment of the included mixed methods studies using the Mixed Methods Appraisal Tool (MMAT) for Mixed Methods Studies

	Screening questions		*Qualitative*				*Quantitative descriptive*				*Mixed methods*		
	Clear mixed methods question	Collected data allow address research question	Relevant sources of qualitative data	Relevant process for analyzing data	Appropriate consideration relation findings–context	Appropriate consideration relation findings–researchers' influence	Relevant sampling strategy	Representative sample	Appropriate measurements	Acceptable response rate	Relevance of mixed methods research design	Integration qualitative and quantitative data	Appropriate consideration limitations integration
Fieldwick et al. 2017	Can't tell	Yes	Yes	Yes	No	No	Yes	Can't tell	No	No	Yes	Yes	No

Provider factors as facilitators or barriers to the provision of PCC

Most provider facilitators and barriers were related to the *professional responsibility*. Being confused about who should (be the entitled provider to) deliver PCC was a frequently reported barrier (Heyes, 2004; Tough, 2004; Mortagy, 2010; Chuang, 2012; Stephenson et al., 2014; Bortolus, 2017; Poels, 2017). Conversely, the belief that having a responsibility in PCC facilitated the provision of PCC (Tough, 2004; Parker, 2010).

The intention to provide PCC appeared to depend on the HCPs' *profession or specialty,* although research findings were often inconsistent. HCPs in obstetrics and gynecology (ob/gyn) practice settings, including obstetrician–gynecologists (Morgan, 2004; Williams, 2006; Burris, 2011), maternal-fetal medicine specialists (Power, 2013), and midwives (Poels, 2017) tended to be more involved in PCC compared with HCPs in non–ob/gyn practice settings such as gynecologists only (Morgan, 2004; Burris, 2011) and general practitioners (Williams, 2006; Poels, 2017). Some studies, however, observed a greater PCC–engagement among family physicians in comparison with midwives and obstetricians (Tough, 2004; van Voorst, 2016). In addition, the intention to provide PCC seemed to depend on which PCC aspect was dealt with. Obstetrician-gynecologists seemed to discuss Pap testing and pregnancy related issues (including folic acid, smoking, drug use, sexual abuse) more frequently than family physicians, while family physicians tended to handle mental health, depression, and workplace stress related topics more often (Tough, 2006). Midwives seemed to assess PCC risk factors more regularly compared with general practitioners (Poels, 2017). Moreover, nurse practitioners in ob/gyn settings were most likely to talk about folic acid while family physicians were least likely to discuss the topic (Williams, 2006).

Having good *knowledge on PCC* was also identified as one of the main facilitators to provide PCC (Miranda, 2003; Tough, 2004; Parker, 2010; Stephenson et al., 2014; Archibald, 2016; Coll, 2016; M'Hamdi, 2017; Poels, 2017). By contrast, lack of *awareness* of PCC and *unfamiliarity* with PCC (e.g. not knowing what PCC involves and what the benefits of PC interventions are) were identified as barriers to the provision of PCC (Archibald, 2016; Fieldwick, 2017; M'Hamdi, 2017; Poels, 2017).

Another influencing factor seemed to be a HCP's *personal attitude*; those considering PCC as a high priority more frequently provided PCC (Heyes, 2004; Morgan et al., 2006) than those having negative perceptions and not being convinced of the importance, need, benefits and efficacy of PCC (Chuang, 2012; Mazza, 2013; van Voorst, 2016; Poels, 2017). Perceiving PCC as specialized rather than routine care was also a barrier for the provision of PCC (Morgan et al., 2006). One study identified lack of motivation as a barrier (Ojukwu, 2016). Being interested or not might have a stimulating (Mortagy, 2010) or restraining influence (Stephenson et al., 2014) on the provision of PCC.

The HCP's *perception of having no opportunity to deliver PCC* was also found to be a considerable barrier for the provision of PCC (Mazza, 2013; Fieldwick, 2017). Some professionals experienced a limited access to women of childbearing age who plan to conceive (McPhie, 2016). *Competing priorities* (e.g. medical, preventive) might also discourage professionals to engage in PCC (Mazza, 2013; Coll, 2016).

Some studies cited *communication* problems as a barrier. HCPs might experience some difficulties in addressing the topic of pregnancy intentions or fertility desires (Schwarz, 2009; Coll, 2016), or did not routinely ask clients for it (Schwarz, 2009). The sensitive nature of the topic also seemed to prevent professionals in beginning a PC-conversation with their clients (McPhie, 2016), which may be attended by a lack of *confidence* (McPhie, 2016). Having good or a lack of confidence (Chuang, 2012; Stephenson et al., 2014), as well as having more or less (years of *work*) *experience* in providing PCC (Morgan, 2004; McClaren, 2008; Bonham, 2010; Poels, 2017) were also found to be either a facilitator or barrier. Moreover, lack of training seemed to hamper HCPs (Heyes, 2004).

Several articles mentioned that a HCP's *workplace* influences the provision of PCC; those working in a university, teaching, or residency training environment (Bonham, 2010), and coming from areas with high levels of morbidity (Parker, 2010) were more likely to engage in PCC. Urban providers tended to discuss folic acid more often than providers in rural areas (Tough, 2008). Another facilitating factor was having *clients of high risk groups*; health care providers seeing lower income clients, and whose practice consisted of at least 10% minorities tended to be more inclined to provide PCC (Williams, 2006). Two studies found a positive association between *female* professionals and the provision of PCC (Heyes, 2004; Tough, 2006).

The following facilitating HCP factors were mentioned in only one study: provider who personally took multivitamin (Williams, 2006); being nonreligious compared to reformed (Poppelaars, 2004); obtaining information from medical journals (Tough, 2004); support from other health care providers (Archibald, 2016); and being uncertified (Abu-Hammad, 2008). Experiencing ethical barriers (M'Hamdi, 2017) was considered to be an additional barrier related to the provision of PCC.

Client factors as facilitators or barriers to the provision of PCC

A total of 14 studies identified *contact with clients only after conception* as the main barrier for HCPs to deliver PCC. This implies clients who do not present (whether consciously or not e.g. due to being unaware of availability and importance of PCC) at preconception stage (Mazza, 2013; Ojukwu, 2016; Fieldwick, 2017; Poels, 2017), and those having unplanned pregnancies (Heyes, 2004; Stephenson et al., 2014; Coll, 2016; McPhie, 2016; Ojukwu, 2016). The aforementioned barrier also implies communication difficulties; the perception that clients are not thinking about having children (McClaren, 2008) or do not (want to) initiate discussions about

pregnancy planning or preconception health, dissuaded HCPs from providing PCC (Heyes, 2004; Schwarz, 2009; Chuang, 2012; Bortolus, 2017). By contrast, client request (Morgan, 2004; Morgan et al., 2006), and mentioning the desire to become pregnant (Morgan, 2004; Power, 2013; van Voorst, 2016) incited HCPs to offer PCC.

Several barriers related to the *client's personal attitude*, seemed to negatively influence the degree to which HCPs are willing to provide PCC, including clients who are not willing to invest time, money, and effort in preconception consultations (Mazza, 2013; M'Hamdi, 2017), not interested in discussing PCC-related topics (Tough, 2004), perceiving PCC as less needed (Ojukwu, 2016) or important (Heyes, 2004), and less attending for health care before pregnancy due to poor understanding of personal risks (Poels, 2017).

The client's *lack of knowledge on PCC* was considered as another impeding factor (Archibald, 2016; Coll, 2016; Ojukwu, 2016). Health care providers also seemed to be susceptible to the extent to which clients are *aware of PCC* or otherwise. While awareness can be seen as a facilitating factor (Stephenson et al., 2014), the client's lack of or limited awareness about the availability and importance of PCC were identified as discouraging factors in the provision of PCC (Mazza, 2013; Archibald, 2016; McPhie, 2016; M'Hamdi, 2017; Poels, 2017).

Furthermore, HCPs mentioned the negative influence of the *client's status*, especially those belonging to high risk groups (e.g. low socioeconomic status, living in deprived areas) (M'Hamdi, 2017). Those clients might be hardest to reach due to lack of self-knowledge, ignorance, and inadmissibility for preconception information (M'Hamdi, 2017; Poels, 2017). The client's ethnicity or race might either hamper or stimulate HCPs to provide PCC. Health care providers were more likely to discuss preconception-related topics if their clients were Jewish (Abu-Hammad, 2008), if the client's race was black (Bonham, 2010), or other than white, black or Hispanic (Burris, 2011). Physicians caring for Native / Aboriginal clients were more likely to inform their clients about drinking prior to pregnancy (Tough, 2007). One study identified a non-western ethnicity as a possible barrier for HCPs (Poels, 2017).

Several studies named the *potential psychosocial impact for clients* as a discouraging factor for HCPs to provide PCC, including the potential to increase anxiety (related to specific information, e.g. teratogenic risk of certain medications) (Schwarz, 2009; Archibald, 2016), as well as the potential to cause stress on relationships (McClaren, 2008). Existing stigmas among clients might also hamper HCPs to initiate PCC (McClaren, 2008; Coll, 2016). However, other articles found that the client's *health status* may trigger HCPs to discuss PCC-related topics. A family history of cystic fibrosis, having a partner who has cystic fibrosis or is a known carrier (Morgan, 2004), suffering from diabetes (Power, 2013) or a chronic disease (van Voorst, 2016), having experienced a miscarriage (van Voorst, 2016), having infertility problems (Fieldwick, 2017), taking medicines (e.g. contraception) (van Voorst, 2016), or having overweight or obesity (Fieldwick, 2017) were mentioned as facilitating factors.

The following facilitating client factors were mentioned in only one or two studies: the client's insurance status (i.e. having a private or other insurance) (Burris, 2011), gender (i.e. female clients) (Bonham, 2010), and age (clients aged 30-34) (Bonham, 2010; Burris, 2011).

Organizational factors as facilitators or barriers to the provision of PCC

The main organizational factors were related to *resources*. Especially lack of time was found to be a major barrier for HCPs to provide PCC (Heyes, 2004; Tough, 2007; McClaren, 2008; Tough, 2008; Schwarz, 2009; Chuang, 2012; Mazza, 2013; Archibald, 2016; Coll, 2016; McPhie, 2016; Ojukwu, 2016; Bortolus, 2017; M'Hamdi, 2017; Poels, 2017). Those time constraints refer to e.g. the decision-making process (Archibald, 2016), the provision of pretest counselling (Archibald, 2016), and other competing preventive care which also needs to be delivered (M'Hamdi, 2017). HCPs in the study of McPhie et al. (2016) considered limited available time as the reason why there is no scope for PCC in both their role and the current health care system. Other resource-related barriers were lack of money (Heyes, 2004; Ojukwu, 2016), lack of space (Heyes, 2004), lack of patient / provider resources for PCC (Mazza, 2013; Coll, 2016), and lack of manpower (Heyes, 2004). The latter includes a limited number of general practitioners (willing) to deliver PCC (Mazza, 2013), and a lack of (access to) local specialists or general practitioners (e.g. long waiting list) (Chuang, 2012; Mazza, 2013). Conversely, the availability of PCC resources (e.g. checklists, patient brochures, handouts, waiting room posters), as well as trained and qualified care providers were identified as organizational facilitators (Schwarz, 2009; Mazza, 2013; Archibald, 2016).

HCPs tended to be less inclined to provide PCC if there was poorly formatted *information* (Tough, 2007; Tough, 2008), or if they experienced difficulties in finding clinically relevant information (e.g. on medications' teratogenicity) (Schwarz, 2009). Disposing of the necessary aids regarding PCC (e.g. online references, computerized decision support, practice protocols), however, stimulated HCPs to engage in PCC (Schwarz, 2009; Mortagy, 2010).

Besides the potential negative influence of resource- and information-related factors, a lack of clear division of *responsibility* concerning PCC was regarded as another barrier; some HCPs still found it unclear who should be the entitled provider for PCC (Mortagy, 2010; Poels, 2017). HCPs also mentioned that PCC (consultations) might cause *burden* on organizational level owing to e.g. an added workload (Heyes, 2004; Mazza, 2013).

Only Baars et al. (2004) identified the provision of genetic counseling in an HCP's own practice as an facilitating factor on organizational level. Limited reproductive options, a selective approach to offering screening (Archibald, 2016), limited collaboration and referrals between HCPs regarding PCC, and existing tension between different health care disciplines (Poels, 2017) were identified once as organizational factors that discourage HCPs to provide PCC.

Societal factors as facilitators or barriers to the provision of PCC

Societal barriers and facilitators were particularly related to the *availability of resources*, *guidelines, and reimbursement*. The degree to which HCPs are triggered to deliver PCC seemed to depend on having access to educational materials for patients (e.g. information leaflets) and professional resources (e.g. evidence based websites) or not (Schwarz, 2009; Mortagy, 2010; Mazza, 2013; Stephenson et al., 2014). HCPs need a society in which patient information and evidence-based guidelines for PCC are available (Heyes, 2004; Mortagy, 2010) and being developed (Archibald, 2016). A lack of PCC-related tools and guidelines were seen as discouraging factors to provide PCC (Mortagy, 2010; Poels, 2017). Being reluctant to provide PCC can also be attributed to financial constraints, including the absence of a costing structure (Poels, 2017), and the lack of a financial compensation for PCC (Schwarz, 2009; M'Hamdi, 2017). A society that equips financial incentives, by contrast, might entice HCPs into providing PCC to their clients (Stephenson et al., 2014). In the study of Archibald et al. (2016) HCPs also identified the performance of economic evaluations of PCC as a facilitating factor.

The following additional societal barriers were mentioned in only one study: rural community norms (e.g. accepting early childbearing, unintended pregnancies) (Chuang, 2012), poor or lack of communication between different health care disciplines that offer PCC (M'Hamdi, 2017), lack of formal professional education on PCC (Poels, 2017), lack of overview of collaboration partners (Poels, 2017), and the organization of the current health care system (e.g. time constraints) (McPhie, 2016).

DISCUSSION

The aim of this review was to provide an overview of barriers and facilitators that could influence the provision of PCC by HCPs. Thirty-one studies were included in this review. Findings of this review suggest that the provision of PCC is influenced by several client, provider, organizational, and societal factors. Most of the factors influencing the provision of PCC were identified as barriers, which might explain why the provision of PCC is low. The majority of the reported barriers were situated at client level (e.g. not contacting a HCP in the preconception stage, negative attitude and lack of knowledge of PCC), and HCP level (e.g. unfavorable attitude and lack of knowledge of PCC, not working in the field of obstetrics and gynecology, and lack of clarity on the responsibility for the provision of PCC). The aforementioned barrier was one of the most reported barriers in the provision of PCC (Heyes, 2004; Tough, 2004; Schwarz, 2009; Mortagy, 2010; Chuang, 2012; Stephenson et al., 2014; McPhie, 2016; Bortolus, 2017; M'Hamdi, 2017; Poels, 2017). Several studies found that HCPs perceive PCC as the responsibility of other HCPs rather than their own responsibility. This lack of clarity of responsibility can be explained by the fact that PCC is still an emerging topic. In 2006, the Centers for Disease Control and Prevention (CDC) were one of the first to develop recommendations to improve preconception health and care

(Johnson et al., 2006). Since then, more attention has been given to PCC with an increased research activity and development of national and global guidelines (Jack et al., 2008; World Health Organization, 2012; Shawe, 2014). However, there is still a lack of clarity regarding who should provide PCC. Most studies and guidelines recommend a shared responsibility between all healthcare providers who have contact with women, from obstetricians/gynecologists to general practitioners, pediatricians, family practice physicians, midwives, nurses, (advanced) midwife/nurse practitioners, and so on (Johnson et al., 2006; Shawe, 2014). The fact that a lot of healthcare providers are responsible for providing preconception care may reduce the sense of individual responsibility and efforts, and may eventually lead to a situation where nobody provides it.

Another frequently reported barrier was the lack of client initiative in the preconception stage to discuss pregnancy planning or preconception health due to unplanned pregnancies and lack of awareness (Heyes, 2004; Morgan, 2004; Schwarz, 2009; Chuang, 2012; Mazza, 2013; Stephenson et al., 2014; Coll, 2016; McPhie, 2016; Ojukwu, 2016; van Voorst, 2016; Bortolus, 2017; Fieldwick, 2017; Poels, 2017). The perception of women as main initiators of a dialogue about pregnancy planning and preconception health may result from the belief that PCC is the responsibility of others, including women's responsibility (Goossens et al., 2014). Another explanation is that HCPs hesitate to pose personal questions about women's reproductive plans because they belief these questions are sensitive or embarrassing. Yet, literature suggests that the majority of clients appreciate a discussion about their reproductive plans and health (Stern et al., 2013). In addition, the research of Wendt and colleagues suggests that women may experience difficulties in raising a conversation about sexual health issues themselves, and therefore, would find it easier if a HCP would initiate a dialogue about these matters (Wendt et al., 2007).

Limited resources were frequently reported barriers at the organizational and societal level. At the organizational level, lack of time was found to be a major barrier for the provision of PCC. Previous research also identified lack of time and heavy workload as one of the most important factors that prevented HCPs from providing health promotion and prevention (Luquis and Paz, 2015). A study in six European countries found that mean consultation length in general practices was 10.7 minutes (Deveugele et al., 2002). Given the restricted amount of time, the opportunities to discuss preconception health promotion may be limited, as physicians need to spend their time discussing more urgent care issues. A possible solution to lack of physician time is to use a team-based PCC approach in which midwives and nurses, and health educators are responsible for general preconception health promotion, and advanced nurse/midwife practitioners and physicians address the more complicated cases.

Lack of reimbursement for PCC, tools and guidelines were the main societal barriers for the provision of PCC. These barriers were also frequently reported in other studies on factors influencing the provision of preventive

health services and health promotion (Luquis and Paz, 2015). Clear evidence-based guidelines, and education materials and tools might support the provision of PCC.

This systematic review has some limitations. First, a number of methodological issues and potential biases were identified in the included studies. More than half of the quantitative studies had a considerable risk of selection bias due to low response rates (Tough, 2004; Tough, 2006; Tough, 2007; Tough, 2008; Bonham, 2010; van Voorst, 2016; Fieldwick, 2017) and convenience sampling (Miranda, 2003). Furthermore, only two quantitative studies used a validated and reliable data collection method (Miranda, 2003) (Baars, 2004), and only Morgan et al. (2004, 2006) and Tough et al. (2006, 2008) performed a sample size or power calculation. Some of the qualitative studies had a relatively small and heterogeneous sample of HCPs (Mortagy, 2010; Coll, 2016; Ojukwu, 2016; Bortolus, 2017), and a rather short interview duration (Coll, 2016; McPhie, 2016). In addition, the authors critically considered their role as researcher and the potential bias and influence during the data collection in only two qualitative studies (McPhie, 2016; Poels, 2017). The aforementioned methodological concerns may affect the validity of the study findings. Second, physicians (e.g. GPs and obstetricians-gynecologist) were overrepresented in this review with 14 studies focusing on physicians only (Miranda, 2003; Baars, 2004; Morgan, 2004; Morgan et al., 2006; Tough, 2006; Tough, 2007; Abu-Hammad, 2008; Bonham, 2010; Burris, 2011; Chuang, 2012; Mazza, 2013; Power, 2013; Ojukwu, 2016; Fieldwick, 2017), and 16 studies included both physicians and non-physicians health care providers (e.g. midwives and nurses) (Heyes, 2004; Poppelaars, 2004; Tough, 2004; Williams, 2006; McClaren, 2008; Tough, 2008; Schwarz, 2009; Mortagy, 2010; Stephenson et al., 2014; Archibald, 2016; Coll, 2016; McPhie, 2016; van Voorst, 2016; Bortolus, 2017; M'Hamdi, 2017; Poels, 2017). Therefore, findings might be less generalizable to non-physician health care providers. In addition, due to heterogeneity in study characteristics, including content of PCC (PCC in general or a specific care domain), target population (general population or subgroups of the population), study country, and health care setting, findings may be less generalizable to a broader context. Third, this heterogeneity in methodology and content of PCC made it impossible to perform a meta-analysis, which would have allowed us to learn more about associated factors of the provision of PCC. Finally, we did not search for grey literature. Therefore, it is possible that some studies might have been missed due to publication bias.

CONCLUSION

To overcome the different client, provider, organizational, and societal barriers, it is necessary to develop and implement multilevel interventions (Bartholomew Eldrigde et al., 2016). At the client level, developing and implementing preconception mass media campaigns with e.g. posters, leaflets, TV spots, mobile applications, and evidence-based websites could improve people's attitude, awareness, and knowledge about preconception

health (Poels et al., 2017; Toivonen, 2017). However, this does not guarantee a preconception lifestyle change (Delissaint and McKyer, 2011; Toivonen, 2017). Therefore, it is important to gain insight in which determinants are associated with the intention to prepare for pregnancy (Toivonen, 2017). The study of intentions to prepare for pregnancy may also be more enlightening than measuring knowledge or attitude alone to assess the effectiveness of a preconception campaign (Toivonen, 2017). In addition, most preconception interventions focus on women only (Toivonen, 2017). Yet, preconception health is considered as a shared responsibility between women and men, therefore, future research should target both future parents (Toivonen, 2017). At provider level, there is a need to define the role and responsibility of the different HCPs in providing PCC. A team-based PCC approach with general PCC provided by nurses and midwives, and specialized individual PCC provided by advanced nurse/midwife practitioners and physicians should be further explored. In addition, further research should be undertaken to investigate barriers and enablers to provide PCC among non-physician HCPs (e.g. midwives, nurses, health educators) as none of the included studies focused solely on factors influencing the provision of PCC by these HCPs. At organizational level, our findings suggest that the development of education materials and tools could facilitate the provision of PCC. The Reproductive Life Plan (RLP), a tool for reproductive health promotion across the life span, might be a feasible tool for promoting reproductive and preconception health in primary care settings, such as student health centers, STD clinics, and community health centers (Stern et al., 2013). Preconception interventions should also be delivered through non-medical channels, for example, through school-based education programs. By integrating preconception health and care in existing sexual health education, the vast majority of the population could be reached. At societal level, the provision of preconception care can be encouraged by developing clear evidence-based guidelines and reimbursing PCC.

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CONFLICT OF INTEREST

None to declare.

REFERENCES

Abu-Hammad T, Dreiher, J., Vardy, D. A., & Cohen, A. D. (2008) Physicians' knowledge and attitudes regarding periconceptional folic acid supplementation: a survey in Southern Israel. Med Sci Monit 14:CR262-CR267.

Archibald A, Hickerton, CL., Wake, SA., Jaques, AM., Cohen, J., Metcalfe, SA. (2016) "It gives them more options": preferences for preconception genetic carrier screening for fragile X syndrome in primary healthcare. J Community Genet 7:159-171.

Baars MJH, Henneman, L., & ten Kate, L. P (2004) Preconceptional cystic fibrosis carrier screening: Opinions of general practitioners, gynecologists, and pediatricians in the Netherlands. Genetic Testing 8:431-436.

Bartholomew Eldrigde LK, Markham CM, Ruiter RAC, Fernandez ME, Kok G, Parcel GS (2016) Planning health promotion programs: an intervention mapping approach, fourth Edition. Hoboken, NJ: Wiley & Sons.

Bonham VL, Knerr, S., Feero, W. G., Stevens, N., Jenkins, J. F., & McBride, C. M (2010) Patient physical characteristics and primary care physician decision making in preconception genetic screening. Public Health Genomics 13:336-344.

Bortolus R, Oprandi, NC., Morassutti, FR., Marchetto, L., Filippini, F., Agricola, E., Tozzi, AE., Castellani, C., Lalatta, F., Rusticali, B., & Mastroiacovo, P. (2017) Why women do not ask for information on preconception health? A qualitative study. BMC Pregnancy Childbirth 17.

Burris HH, & Werler, M. M (2011) U.S. provider reported folic acid or multivitamin ordering for non-pregnant women of childbearing age: NAMCS and NHAMCS, 2001-2006. Maternal and child health journal 11:312-319.

Chuang CH, Hwang, S. W., McCall-Hosenfeld, J. S., Rosenwasser, L., Hillemeier, M. M., & Weisman, C. S (2012) Primary care physicians' perceptions of barriers to preventive reproductive health care in rural communities. Perspect Sex Reprod Health 44:78-83.

Coll A, Potter, JE., Chakhtoura, N., Alcaide, ML., Cook, R., & Jones, DL. (2016) Providers' perspectives on preconception counseling and safer conception for HIV-infected women. AIDS Care 28:513-518.

Curtis M, Abelman S, Schulkin J, Williams JL, Fassett EM (2006) Do we practice what we preach? A review of actual clinical practice with regards to preconception care guidelines. Matern Child Health J 10:S53-58.

Delissaint D, McKyer EL (2011) A systematic review of factors utilized in preconception health behavior research. Health Educ Behav 38:603-616.

Deveugele M, Derese A, van den Brink-Muinen A, Bensing J, De Maeseneer J (2002) Consultation length in general practice: cross sectional study in six European countries. BMJ (Clinical research ed) 325:472.

Fieldwick D, Smith, A., & Paterson, H. (2017) General practitioners and preconception weight management in New Zealand. Aust N Z J Obstet Gynaecol:1-6.

Goossens J, Delbaere I, Van Lancker A, Beeckman D, Verhaeghe S, Van Hecke A (2014) Cancer patients' and professional caregivers' needs, preferences and factors associated with receiving and providing fertility-

related information: a mixed-methods systematic review. International journal of nursing studies 51:300-319.

Heyes T, Long, S., & Mathers, N. (2004) Preconception care: practice and beliefs of primary care workers. Fam Pract 21:22-27.

Jack BW, Atrash H, Coonrod DV, Moos MK, O'Donnell J, Johnson K (2008) The clinical content of preconception care: an overview and preparation of this supplement. Am J Obstet Gynecol 199:S266-279.

Johnson K, Posner SF, Biermann J, Cordero JF, Atrash HK, Parker CS, Boulet S, Curtis MG (2006) Recommendations to improve preconception health and health care--United States. A report of the CDC/ATSDR Preconception Care Work Group and the Select Panel on Preconception Care. MMWR Recomm Rep 55:1-23.

Korenbrot CC, Steinberg A, Bender C, Newberry S (2002) Preconception care: a systematic review. Matern Child Health J 6:75-88.

Luquis RR, Paz HL (2015) Attitudes About and Practices of Health Promotion and Prevention Among Primary Care Providers. Health promotion practice 16:745-755.

M'Hamdi H, van Voorst, SF., Pinxten, W., Hilhorst, MT., Steegers, EAP (2017) Barriers in the Uptake and Delivery of Preconception Care: Exploring the Views of Care Providers. Maternal and child health journal 21:21-28.

Mazza D, Chapman, A., & Michie, S (2013) Barriers to the implementation of preconception care guidelines as perceived by general practitioners: a qualitative study. BMC Health Serv Res 13.

McClaren BJ, Delatycki, M. B., Collins, V., Metcalfe, S. A., & Aitken, M (2008) 'It is not in my world': An exploration of attitudes and influences associated with cystic fibrosis carrier screening. Eur J Hum Genet 16:431-444.

McLeroy KR, Bibeau D, Steckler A, Glanz K (1988) An ecological perspective on health promotion programs. Health Educ Q 15:351-377.

McPhie S, Skouteris, H., Millar, L., Olsson, C., Campbell, K., van der Pligt, P., Dodd, J., & Hill, B. (2016) Preconception weight management: an untapped area of women's health. Aust J Prim Health.

Miranda A, Davila Torres, R. R., Gorrin Peralta, J. J., & Montes, d. L., I (2003) Puerto Rican primary physicians' knowledge about folic acid supplementation for the prevention of neural tube defects. Birth Defects ResA ClinMolTeratol 67:971-973.

Morgan MA, Hawks D, Zinberg S, Schulkin J (2006) What obstetrician-gynecologists think of preconception care. Matern Child Health J 10:S59-65.

Morgan MA, Driscoll, D. A., Mennuti, M. T., & Schulkin, J (2004) Practice patterns of obstetrician-gynecologists regarding preconception and prenatal screening for cystic fibrosis. GenetMed 6:410-411.

Mortagy I, Kielmann, K., Baldeweg, S. E., Modder, J., & Pierce, M. B (2010) Integrating preconception care for women with diabetes into primary care: a qualitative study. Br J Gen Pract 60:811-821.

Ojukwu O, Patel, D., Stephenson, J., Howden, B., & Shawe, J. (2016) General practitioners' knowledge, attitudes and views of providing preconception care: a qualitative investigation. Ups J Med Sci 121:256-263.

Parker CS, Ghaddar, S., Zhang, Q., & Cooke, B (2010) Factors Affecting the Willingness of Counselors to Integrate Preconception Care into Sexually Transmitted Disease Clinics. J Womens Health Issues 20:20-21.

Poels M, van Stel HF, Franx A, Koster MPH (2017) Actively preparing for pregnancy is associated with healthier lifestyle of women during the preconception period. Midwifery 50:228-234.

Poels M, Koster MP, Boeije HR, Franx A, van Stel HF (2016) Why Do Women Not Use Preconception Care? A Systematic Review On Barriers And Facilitators. Obstet Gynecol Surv 71:603-612.

Poels M, Koster, MPH., Franx, A., & van Stel, HF. (2017) Healthcare providers' views on the delivery of preconception care in a local community setting in the Netherlands. BMC Health Serv Res 17.

Poppelaars FA, Ader, H. J., Cornel, M. C., Henneman, L., Hermens, R. P., van der Wal, G. et al. (2004) Attitudes of potential providers towards preconceptional cystic fibrosis carrier screening. . J Genet Couns 13:31-44.

Power M, Wilson, EK., Hogan, SO., Loft, JD., Williams, JL., Mersereau, PW., & Schulkin, J. (2013) Patterns of Preconception, Prenatal and Postnatal Care for Diabetic Women by Obstetrician-Gynecologists. J Reprod Med 58:7-14.

Schwarz E, Santucci, A., Borrero, S., Akers, A., Nikolasjki, C., & Gold, MA. (2009) Perspectives of primary care clinicians on teratogenic risk counseling Birth Defects Res A Clin Mol Teratol 85:858-863.

Shawe J, Delbaere, I., Ekstrand, M., Hegaard, HK., Larsson, M., Mastroiacovo, P., Stern, J., Steegers, E., Stephenson, J., & Tydén, T. (2014) Preconception care policy, guidelines, recommendations and services across six European countries: Belgium (Flanders), Denmark, Italy, the Netherlands, Sweden and the United Kingdom. Eur J Contracept Reprod Health Care:1-11.

Steel A, Lucke, J., Reid, R., & Adams, J. (2016) A systematic review of women's and health professional's attitudes and experience of preconception care service delivery. Fam Pract 33:588-595.

Stephenson J, Patel D, Barrett G, Howden B, Copas A, Ojukwu O, Pandya P, Shawe J (2014) How do women prepare for pregnancy? Preconception experiences of women attending antenatal services and views of health professionals. PloS one 9:e103085.

Stern J, Larsson M, Kristiansson P, Tydén T (2013) Introducing reproductive life plan-based information in contraceptive counselling: an RCT. Human Reproduction 28:2450-2461.

Toivonen K, Oinonen, KA., & Duchene, KM. (2017) Preconception health behaviours: A scoping review. Prev Med 96:1-15.

Tough S, Clarke, M., & Cook, J (2007) Fetal alcohol spectrum disorder prevention approaches among Canadian physicians by proportion of Native/Aboriginal patients: practices during the preconception and prenatal periods. Maternal and child health journal 11:381-393.

Tough S, Clarke, M., Hicks, M., & Clarren, S. (2004) Clinical practice characteristics and preconception counseling strategies of health care providers who recommend alcohol abstinence during pregnancy. Alcohol Clin Exp Res 28.

Tough S, Ediger, K., Hicks, M., & Clarke, M. (2008) Rural-urban differences in provder practice related to preconception counselling and fetal alcohol spectrum disorders. Can J Rural Med 13.

Tough SC, Clarke, M., Hicks, M., & Cook, J (2006) Pre-conception practices among family physicians and obstetrician-gynaecologists: results from a national survey. J Obstet Gynaecol Can 28:780-788.

United Nations (2015) Transforming our World: The 2030 Agenda for Sustainable Development In.

van Voorst S, Plasschaert, S, de Jong-Potjer, L, Steegers, E, & Denktaş, S. (2016) Current practice of preconception care by primary caregivers in the Netherlands. Eur J Contracept Reprod Health Care 21:251-258.

Vyncke V, De Clercq B, Stevens V, Costongs C, Barbareschi G, Jónsson SH, Curvo SD, Kebza V, Currie C, Maes L (2013) Does neighbourhood social capital aid in levelling the social gradient in the health and well-being of children and adolescents? A literature review. BMC public health 13: 65.

Wendt E, Hildingh C, Lidell E, Westerstahl A, Baigi A, Marklund B (2007) Young women's sexual health and their views on dialogue with health professionals. Acta obstetricia et gynecologica Scandinavica 86:590-595.

Williams J, Abelman, SM., Fassett, EM., Stone, CE., Petrini, JR., Damus, K., & Mulinare, J. (2006) Health Care Provider Knowledge and Practices Regarding Folic Acid, United States, 2002-2003. Maternal and child health journal 10:S67-S72.

World Health Organization (2012) Meeting to Develop a Global Consensus on Preconception Care to Reduce Maternal and Childhood Mortality and Morbidity. In. Geneva: World Health Organization Headquarters.

CHAPTER 9

GENERAL DISCUSSION

1. Summary of the main findings

There is growing evidence that improving women's and men's health before conception can lead to improved maternal and child health outcomes (Korenbrot et al., 2002; Johnson et al., 2006; Wahabi et al., 2010; Yi et al., 2011; Ramakrishnan et al., 2012; Wahabi et al., 2012; World Health Organization, 2012; Shannon et al., 2013; Dean et al., 2014; Shannon et al., 2014b; Lan et al., 2017). Although several recommendations to improve preconception health and care have been developed, most women and men do not adjust their lifestyle before pregnancy, and most healthcare providers do not provide preconception care (Frey and Files, 2006; Johnson et al., 2006; Williams et al., 2012; World Health Organization, 2012; Stephenson et al., 2014; van Voorst et al., 2016; Poels et al., 2017a). In an effort to inform and enhance future intervention development for improving preconception health and care, this dissertation provides an overview of (1) preconception needs, pregnancy planning and preconception lifestyle changes, and associated factors among reproductive-aged women and men; and (2) healthcare providers' perspectives on barriers and facilitators to the provision of preconception care.

1.1 Summary of the main findings of the different studies

Findings from the first study in chapter 2 showed that the majority of women (75%) want to receive preconception care, and preferably directly from a healthcare provider. Most women expressed an information need, and few women a support need. Information and support needs were higher among women with specific health conditions. The results of this study are very promising, because they suggest a high interest in preconception health and care (e.g., information on nutrition and nutritional supplements, working conditions, and sports). On the other hand, the interest in some lifestyle topics was low, including on how to obtain a healthy weight, how to increase physical activity, the influence of (passive) smoking and alcohol, and fertility and family planning. Most women indicated that they were already fully informed about these topics.

To investigate this issue in more detail, pregnancy planning was investigated in chapters 3 to 4. The 'London Measure of Unplanned Pregnancies' (LMUP) questionnaire was first translated into Dutch, and the psychometric properties were investigated in chapter 3. The valid and reliable Dutch version of the LMUP was used to investigate planned and unplanned pregnancies ending in birth in chapter 4. The results of this study demonstrated that the majority (83%) of the pregnancies were planned, 15% were ambivalent, and 2% unplanned. These results are in line with those of the SEXPERT study in Flanders, showing that 82% of the continued pregnancies during the last 10 years were planned (92% of the pregnancies were continued, of which 75% were planned) (Buysse et al., 2014). The findings of the study in chapter 4 also revealed that

unplanned pregnancies were more common among women of lower socio-economic status (SES) and multiparous women (one or more previous childbirths), and were associated with adverse pregnancy outcomes.

Findings from the fourth study in chapter 5 showed that most women who planned their pregnancy (83%) reported one or more lifestyle changes in preparation for pregnancy. Overall, nulliparous women and women with a previous miscarriage were more likely to prepare for pregnancy, while women of lower SES were less likely to prepare for pregnancy. Half of the women obtained advice about preconception health, and most of them received their advice from a professional caregiver. Three-quarters of the women who did not improve their lifestyle before conceiving reported one or more risk factors for adverse pregnancy outcomes.

Socio-demographic and psychosocial factors associated with the intention to prepare for pregnancy in women and men were investigated in the fifth and sixth study (chapters 6 and 7, respectively). Self-efficacy and attitude were positively associated with a higher intention to prepare for pregnancy in both women and men. In addition, experiencing negative emotions and beliefs about preconception health behaviors such as stress and the belief that preconception health and care is medicalization of conception, was associated with a lower intention to prepare for pregnancy in women and men. Additional factors were found in the study among women. Women with a higher knowledge score, nulliparous women, and those with a normal weight had a higher intention score, while lack of perceived need for preconception lifestyle changes was associated with lower intention to prepare for pregnancy. In the study with men, social influence of the close social environment was the only additional factor associated with a higher intention to prepare for pregnancy. None of the socio-demographic factors were significantly associated with the intention score in the study with men. These findings provide insight into which psychosocial factors are associated with the intention to prepare for pregnancy, and thus, should be targeted in preconception interventions to enhance preconception lifestyle changes.

The results of the systematic review in chapter 8 indicated that the provision of preconception care by healthcare providers is influenced by several client factors as mentioned above (e.g., pregnancy planning, knowledge, attitude), but also by provider, organizational, and societal factors. Lack of clarity on the responsibility for the provision of preconception care was one of the most reported barriers for healthcare providers to deliver preconception care. Several studies showed that healthcare providers perceive preconception care as the responsibility of others rather than their own responsibility (Heyes, 2004; Tough, 2004; Schwarz, 2009; Mortagy, 2010; Chuang, 2012; Stephenson et al., 2014; McPhie, 2016; Bortolus, 2017; M'Hamdi, 2017; Poels, 2017). To date, most guidelines recommend a shared responsibility of all (healthcare)

providers who have contact with reproductive-aged women and men, which may reduce the sense of individual responsibility and efforts (Weldon and Gargano, 1985; Karau and Williams, 1993; Atrash et al., 2006; Johnson et al., 2006; Posner et al., 2006; Shawe, 2014; Frayne et al., 2016; Shih and Susanto, 2016). Time, financial, and resource (e.g., guidelines and tools) constraints were the most important organizational and societal barriers for the provision of preconception care (Schwarz, 2009; Mortagy, 2010; Mazza, 2013; Stephenson et al., 2014; M'Hamdi, 2017; Poels, 2017).

1.2 Summary of the overall findings

Over the different studies that were conducted in this dissertation, a number of interesting findings and patterns became clear.

Socio-demographic characteristics

Previous literature as well as the results from chapter 4 and 5 showed that *women of lower SES* were less likely to plan and prepare a pregnancy (Elsinga et al., 2006; van der Pal-de Bruin et al., 2008; Harelick et al., 2011; Maxson and Miranda, 2011; Timmermans et al., 2011; Denny et al., 2012; Weightman et al., 2012; de Graaf et al., 2013; Mallard and Houghton, 2013; Waelput et al., 2017). Women of lower SES may experience more ambivalence towards avoiding a pregnancy because motherhood is perceived as one of the few attainable goals that will provide personal satisfaction and achievement, which can result in a lack or an inadequate use of contraceptives (Fedorowicz et al., 2014; Pratt et al., 2014). Even when conscious planning to become pregnant, women of lower SES were less likely to report preconception lifestyle changes compared to women of higher SES. However, previous research has shown that these women would benefit most from preconception lifestyle changes because they have a higher prevalence of preconception risk factors (van der Pal-de Bruin et al., 2008; Harelick et al., 2011; Timmermans et al., 2011; Denny et al., 2012; Weightman et al., 2012; de Graaf et al., 2013; Waelput et al., 2017). Additional analyses were performed on the datasets of the studies in this dissertation to ascertain the association between SES (based on education) and preconception risk factors (Table 1). The results of the additional analyses support previous findings and showed that lower educated women and men were significantly more likely to smoke compared to higher educated counterparts. Alcohol use was not significantly associated with educational level, except in the dataset on preconception lifestyle changes, indicating that higher educated women were significantly more likely to consume alcohol preconceptionally (Table 1). Furthermore, lower educated women were more likely to have a chronic disease, to be overweight or obese, and less likely to have taken multivitamins or folic acid in the preconception period compared to higher educated women (Table 1).

A possible explanation for this finding is that women and men of lower SES may experience more and different barriers to preconception lifestyle changes (e.g., low health literacy, lack of child care or public transportation, lack of energy and time)(Mazza and Chapman, 2010; Murphy et al., 2010; Zhu et al., 2012; Hogan et al., 2013; Squiers et al., 2013b; Temel et al., 2013; Tuomainen et al., 2013; Atal and Cheng, 2016). It is also possible that some (non-Western) women and men of lower SES have certain cultural, religious or social beliefs regarding health and (pre-)pregnancy, making them less inclined to prepare for pregnancy (Hill et al., 2012; Boerleider et al., 2013; Raman et al., 2016; Withers et al., 2018). Additional analyses were conducted on the dataset of the factor study in women (chapter 6) to investigate which psychosocial factors are associated with the intention to prepare for pregnancy in lower educated, non-student women (Table 2 and 3). Due to the low proportion of lower educated, non-student men (n=28), no additional analyses were performed on the database of the factor study in men (chapter 7). In lower educated women, a positive attitude and self-efficacy were associated with a higher intention to prepare for pregnancy, while a lack of perceived need and experiencing negative emotions and beliefs about preparing for pregnancy (e.g., stress and believing that preconception health and care is a medicalization of the conception) were associated with a lower intention score (Table 2 and 3).

Consistent with previous findings (Wallace and Hurwitz, 1998; Hosli et al., 2008; Mazza and Chapman, 2010; Murphy et al., 2010; Zhu et al., 2012; Temel et al., 2013; Tuomainen et al., 2013; van der Zee et al., 2013), *multiparous women* were less likely to plan and prepare a pregnancy compared to nulliparous women (in chapter 4, 5 and 6). Although a recent study of Bodin et al. (2017) found that first-time fathers were also more likely to have made a preconception lifestyle adjustment, our study described in chapter 7 was unable to demonstrate this association in men.

Little is known about why multiparous women have an increased risk of an unplanned pregnancy. It is possible that some multiparous women use less effective contraception due to concerns about the safety of hormonal contraception on breastfeeding, or because they have a desire for another pregnancy (Cwiak et al., 2004; Tang et al., 2013; Higgings, 2017). Multiparous women planning to become pregnant may have a more “relaxed” attitude regarding preconception risks after a successful pregnancy with a healthy child, and therefore, are less likely to change their lifestyle before becoming pregnant. It is also possible that multiparous women and men wrongly believe to have sufficient knowledge about preconception health after a past pregnancy experience (Poels et al., 2016). Another hypothesis is that these women actually have less preconception risk factors compared to nulliparous counterparts, and thus, do not need to adopt a healthier lifestyle preconceptionally. Supplementary analyses were performed on the datasets of the studies included in this dissertation to investigate the latter hypothesis. With the exception of a few differences, the preconception risks were similar between nulliparous and multiparous women and men (Table 4). These findings suggest that

the latter hypothesis might be unlikely, and thus, that multiparous women and men can also benefit from preconception lifestyle changes and care.

Additional analyses were performed on the dataset of the factor study in women (chapter 6) to investigate which psychosocial factors are associated with the intention to prepare for pregnancy in multiparous women. Due to low proportion of multiparous men (n=40), no additional analyses were performed on the dataset of the factor study in men (chapter 7). In these women, attitude, self-efficacy, and the opinion of important others (partner, family, friends, colleagues, and healthcare providers) were positively associated with the intention, while negative emotions and beliefs about preparing for pregnancy decreased the likelihood of intending to prepare for pregnancy (Table 5 and 6). These results provide insight into which factors are associated with the intention to prepare for pregnancy in multiparous women, and should be targeted in preconception interventions for multiparous women.

The studies in chapter 6 and 7 suggest *gender differences* in preconception health interest. Although more efforts were made to recruit men, the response rate remained lower compared to women (304 *vs.* 1722). Additional analyses on the databases of the factor study in men and women (chapters 6 and 7) showed that the intention to prepare for pregnancy was higher in women compared to men (0.84 *vs.* 0.71 on a 0 – 1 scale, $p<0.001$). These results are in line with previous research on preconception lifestyle changes in women and men, showing that women reported more preconception lifestyle adjustments than men (Stephenson et al., 2014; Stern et al., 2016; Bodin et al., 2017; Poels et al., 2017a)

There are several possible explanations for this finding. Previous studies reported more unhealthy or risk behaviors in men, as well as a lower awareness and interest in a healthy lifestyle compared to women (Kritsotakis et al., 2016; Meader et al., 2016; Vari et al., 2016). It is possible that these findings can be extended to preconception health. For example, additional analyses on the datasets of study 5 and 6 (chapters 6 and 7) revealed that the knowledge about preconception health was lower in men than women (9 *vs.* 11 on the 0 – 17 scale, $p<0.001$), which is in line with previous studies (Mitchell et al., 2012; Charafeddine et al., 2014; Temel et al., 2015a). Another explanation is that fathers-to-be fall into a secondary role and are excluded during the (pre-)pregnancy period due to social and cultural norms and beliefs, as well as healthcare practices focusing on women only.

Some studies have suggested an association between the *specificity of pregnancy plans* and preconception health behaviors. For example, a large cross-sectional study of Green-Raleigh et al. (2005) found that women who were planning a pregnancy within the next year were less likely to report smoking (OR 0.6, 95% CI 0.42 – 0.96) and more likely to report taking a multivitamin regularly (OR 1.4, 95%CI 1.11 – 1.80) compared to women

not planning a pregnancy. A similar association was found in the factor study in women outlined in chapter 6. In the simple linear regression analysis, a desire to conceive within one year was associated with a higher intention to prepare for pregnancy compared to not planning a pregnancy within the next year (0.87 *vs.* 0.82 on the 0 – 1 scale, p< 0.001). However, the association was only borderline significant in the multiple model (p=0.07). Similar findings were found in the study with men (chapter 7). Planning to conceive within one year was associated with a higher intention score compared to future pregnancy plans (0.77 *vs.* 0.70, on the 0 – 1 scale, p=0.02). However, the association was only borderline significant in the multiple regression model (p=0.07).

This finding can be explained by the fact that when people are approaching their goal (becoming pregnant soon), they will become more receptive to preconception health messages and more motivated to engage in preconception lifestyle changes compared to women and men who have future pregnancy plans (World Health Organization, 2012; Squiers et al., 2013a).

Preconception risk factors and clustering

Patterns in preconception risk factors were found across the studies described in chapters 2 to 7. One fourth to one third of the women were *overweight or obese* in these studies, which is in line with other epidemiological studies in Flanders (Bogaerts et al., 2013; Bogaerts, 2014). However, the results of the preconception needs in chapter 2 indicated a low interest in information on physical activity and obtaining a healthy weight. In addition, the studies in chapter 5 and 6 found that only few overweight or obese women reported to obtain (18%) or the intention to obtain (47%) a healthier weight in the preconception period, respectively. Similar findings were found in men; 20% was obese or overweight, of whom 44% intended to lose weight in the preconception period (chapter 7).

A similar trend is seen regarding *alcohol consumption*. The majority of the women reported to be fully informed (56%) or indicated to have no need for information (24%) about alcohol consumption during the preconception period or pregnancy (in chapter 2). Surprisingly, 52% and 51% of women who were trying to conceive in the studies in chapter 2 and 6, respectively, and 55% of the women who planned their pregnancy in the study in chapter 5 reported to consume alcohol in the preconception period. Additionally, almost one in four women (23%) with a planned pregnancy reported to consume alcohol during their pregnancy, with an average of 2 drinks per week (in chapter 5). Similar findings were found in men in the study outlined in chapter 7; 80% of the men consumed alcohol, of which only 42% intended to reduce their consumption in the preconception period. These findings are striking since both alcohol consumption and overweight or obesity before and during the pregnancy are associated with negative effects on fertility and adverse reproductive

outcomes (Floyd et al., 2008; Zain and Norman, 2008; Campbell et al., 2015; Fullston et al., 2017; Kalliala et al., 2017; Ricci et al., 2017).Therefore, these issues need to be addressed prior to conception.

Additional analyses were performed on the datasets of all studies in this dissertation to further explore the *clustering of preconception risk factors* among women and men. Results of these additional analyses showed that preconception smoking significantly clustered with alcohol use, a history of drug use, and lack of multivitamin/folic acid intake preconceptionally (Table 7). These results are in line with previous research that reported a clustering of smoking with alcohol and drug use (Poortinga, 2007; Erickson and Arbour, 2012; Ferreira da Costa et al., 2013; Passey et al., 2014; Noble et al., 2015; Meader et al., 2016), and support the importance of addressing multiple risk factors for adverse pregnancy outcomes simultaneously.

The organization of preconception care

The studies described in chapters 2 to 6 showed that the proportion of women who received preconception care (34% to 62%) was lower compared with the proportion of women that expressed interest in preconception care in the study in chapter 2 (75%). In particular, there was a great contrast between the proportion of women who would like to receive and actually received preconception information from a midwife described in chapters 2 and 5 (73% *vs.* 3%, respectively). The results of the systematic review in chapter 8 indicate that midwives may need to overcome more barriers compared to gynecologists and general practitioners due to few contact with non-pregnant women and lack of reimbursement for preconception care. To explore whether midwives in Flanders experience similar barriers to the provision of preconception care, an inquiry was conducted in December 2017 among midwives indicating on the website of the Flemish Association of Midwives (VBOV) to provide preconception care. In total, 60 midwives (response rate 44%) responded on the e-mail with the question, "how many times did you provide preconception care during the previous 2 months?". Thirty-three per cent reported having offered preconception care during the last three months, with 75% of them providing it only one time. Several midwives indicated that women and couples are unfamiliar with the concept of preconception care, and a preconception consult by midwives (n=17). In addition, lack of reimbursement (n=16), and the gynecologist as primary healthcare provider (n=5) were mentioned as additional barriers to the provision of preconception care by midwives (unpublished data). This latter finding was also confirmed in the studies described in chapter 2 and 5. The majority of women in these studies wanted and did receive preconception care from a gynecologist (93% and 68% - 82%, respectively).

2. Strengths and limitations

This research has several strengths. The combination of original research and a comprehensive, systematic review provided insight into women's, men's, and healthcare providers' perspectives on preconception health and care, which is a good starting point for future intervention development. Another strength is that the instruments used in this research were developed and validated in a comprehensive and systematic manner. For the studies described in chapters 3 to 5, a major strength was the combination of self-reported data and data extracted from medical records which resulted in comprehensive data.

Despite the strengths of this research, there are several limitations that need to be considered in interpreting the results. A first limitation is that there was an overrepresentation of women and men with higher SES in all the studies in this dissertation. This can be the result of the self-selected nature of the sample in the studies in chapters 2, 6 and 7 leading to selection bias. Moreover, in chapters 2 to 5 the Dutch-only survey language may have led to sampling bias. It is also possible that women with adverse birth outcomes, which is often associated with lower SES, were not informed about the study to avoid overburdening. Some of them may also have refused to participate because of emotions as shame or guilt, leading to sampling and non-response bias, respectively (chapters 3 to 5). To increase the representation of people with lower SES, several measures were undertaken in the factor study in women and men in chapters 6 and 7: the use of incentives, recruitment from community settings (e.g., secondary schools and community health centers), and the provision of an English version of the questionnaire. Nevertheless, the current findings must be extended with future research focusing on (non-Western) women and men with lower SES. These groups are often described as "hard-to-reach" in health and medical research due to several barriers including mistrust in research, cultural beliefs, and language or literacy problems (Bonevski et al., 2014; Lee et al., 2014). Strategies to address these barriers are the use of multilingual and/or culturally trained fieldworkers or health professionals (Bonevski et al., 2014; Lee et al., 2014), the use of incentives (Bonevski et al., 2014), and using technology-based strategies to collect data, such as the voice-based, electronic questionnaire (Bonevski et al., 2014; Jandee et al., 2014; Lee et al., 2014).

Second, the study population in the preconception needs study (chapter 2) and the pregnancy planning study (chapters 3 to 5) were limited to women only. Therefore, the results of these studies should be expanded to reproductive-aged men in future research. The needs assessment instrument was developed and pilot tested in both women and men, and can be used in a future study with men. Strategies to recruit men include the use of incentives (Tishler and Bartholomae, 2002), collaboration with gatekeepers trusted by the participants (Namageyo-Funa et al., 2014); and proactive recruitment, e.g. face to face contact (Namageyo-Funa et al., 2014). The study on pregnancy planning was limited to women with pregnancies ending in birth. Therefore,

these results should also be extended with further research in women with pregnancies ending in abortion. It would be interesting to perform a cohort study where women and men are recruited during the first trimester of the pregnancy in hospital and abortion clinic settings. However, performing a cohort study is time-consuming and labor intensive, with a high risk of drop out.

Third, overall, the response rate and sample size were too low to detect adverse reproductive outcomes with a low prevalence (e.g., HELLP syndrome or mors in utero) in chapter 4, or to use inferential statistics in order to identify associations between dependent and independent variables with low frequencies (e.g. induced abortion, intimate partner violence, drug use) in chapters 2 to 5, and chapter 7. Adverse reproductive outcomes and unhealthy or risk behavior is often associated with lower SES. As aforementioned, people of low SES and men were difficult to reach and underrepresented in our research, and thus, specific strategies to include these groups are needed as described above.

Fourth, all original studies in this dissertation used a cross-sectional design. A disadvantage of this study design is that it does not permit conclusions on the direction of associations. For example, in the study on pregnancy planning in chapter 4, an association was found between pregnancy planning and intimate partner violence (IPV). It is unclear whether IPV is either a result of a less planned pregnancy, or a cause of less planned pregnancies. Prospective cohort studies are needed to investigate the causal relationship between variables.

Another limitation in this dissertation is that preconception lifestyle changes in chapter 5 were assessed via retrospective (after birth) self-report. The drawbacks of retrospective data collection are the risk for social desirability and recall bias. Preconception lifestyle changes were examined by one item in the LMUP, “Before you became pregnant, did you do anything to improve your health in preparation for pregnancy?”. Although the original LMUP is found to be stable over time (Barrett et al., 2004), its psychometric properties may not be applicable to one isolated item of the instrument. Therefore, the results of this study need to be confirmed in further prospective research in couples planning to conceive. In addition, the intention to prepare for pregnancy in women and men was assessed in the studies in chapter 6 and 7, as opposed to preconception behavior itself. Although behavioral intention is viewed as the primary determinant of the actual behavior, it is possible that other factors play a role when the behavior is attempted (de Vries et al., 1988; Devries and Backbier, 1994; Lechner and Devries, 1995; De Vries et al., 1998). In addition, the ASE model is grounded on the belief that behavior is the result of a rational decision or plan (Sniehotta et al., 2014). However, people do not always make rational and calculated decisions; routine habits, unconscious influences, or conflicting goals might also influence behavior, which was not captured in the studies in chapter 6 and 7 (Deutsch and Strack, 2006; Hoffman et al., 2008; Frankish, 2010; Sniehotta et al., 2014). Therefore, future studies should use a

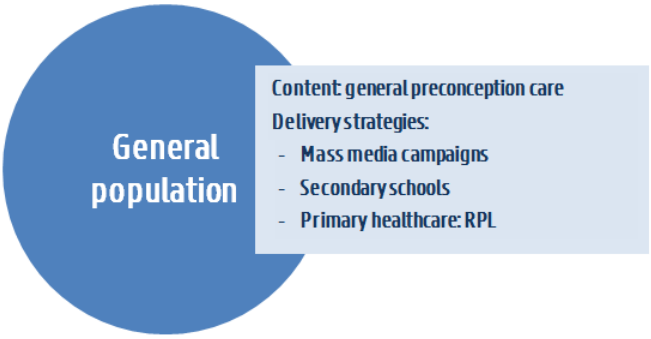
longitudinal design to assess whether the intention, psychosocial determinants and impulsive processes (e.g. habits, emotions) have an influence on the actual preconception health behaviors.

3. Recommendations for practice and future interventions

Based on the insights of this research, several recommendations for practice and future interventions can be made. The proposed intervention methods and strategies need to be further investigated to determine whether these are
effective to enhance preconception health behaviors.

Recommendation 1:

Increasing the awareness and familiarity with preconception health and care among the general population



Based on the results of this dissertation and findings from previous studies (Charron-Prochownik et al., 2006; Canady et al., 2008; Murphy et al., 2010; Mitchell et al., 2012; Zhu et al., 2012; Squiers et al., 2013b; Tuomainen et al., 2013; O'Higgins et al., 2014; Poels et al., 2017b), it is recommended to increase the awareness and familiarity of the general population with preconception health and care. In order to reach the majority of the population, it is important to spread a general message about the importance of preconception health and care through various delivery channels, both within and outside health facilities (Lassi et al., 2014; Shannon et al., 2014b; World Health Organization, 2012). In addition, for an intervention to be effective, it is important to select appropriate behavior change methods and translate these into practical applications that match with the identified determinants (in this case 'awareness' and 'conceptual familiarity'), the specific population, and the context (Kok et al., 2016). Based on the results of this dissertation and existing literature, we will propose some potential intervention methods and strategies, however, more research is needed to investigate if these are indeed effective to increase the awareness and familiarity with preconception health and care among the general population.

Mass media campaigns can produce positive changes in health-related awareness and behaviors across large populations (Wakefield et al., 2010). Framing (i.e., the use of gain-framed messages emphasizing the importance of the behavior) and reinforcement (i.e., linking behavior to a consequence that increases the

behavior's degree, frequency or likelihood) are two methods to increase the awareness and familiarity with preconception health (Kok et al., 2016). One practical translation of these methods can be the use of health messages that suggest that taking care of a baby starts before the pregnancy, e.g. by performing preconception lifestyle changes. These health messages could be disseminated through TV channels, radio programs, and print media (e.g., flyers, posters, billboards) to reach a broad audience. Another, relatively inexpensive and easy strategy to reach a large part of the reproductive-aged population is placing a sticker on oral contraceptives packages with preconception health messages (Schrander-Stumpel, 1999; de Walle and de Jong-van den Berg, 2008).

The use of local celebrities to promote a healthy image of preparing for pregnancy is also suggested in the literature (Lassi et al., 2014). One application could be a role-model-story in a popular television soap opera, for example in the popular Flemish soap 'Thuis' (in English, 'Home') that reach around 1.4 million viewers. A storyline about preconception health could be created in which a familiar character or couple wants to become pregnant in a healthy manner and learns about preconception lifestyle changes. Because people identify themselves with the role-model, they are reinforced to perform preconception lifestyle changes when trying to conceive (Kok et al., 2016). To reach a younger audience, it would be interesting to include the topic of (pre-)pregnancy health and care in the educational television program 'The dr. Bea Show' that provides sex education in a playful and accessible way to children between 9 and 12 years old and reaches 150 000 viewers.

Although large mass media campaigns have the potential to reach a lot of people and increase their awareness, they are not always sufficient for effective behavior change, including preconception lifestyle changes (Van der Pal-de Bruin et al., 2000; Wakefield et al., 2010; Hammiche et al., 2011; Tuomainen et al., 2013; Temel et al., 2015a; Young et al., 2017). Especially habitual or ongoing behavior is difficult to change with mass media campaigns (Wakefield et al., 2010). However, the likelihood of success may be increased by multiple intervention strategies (Abroms and Maibach, 2008; Wakefield et al., 2010). More research is needed to assess the lasting effect of a campaign on preconception awareness and lifestyle changes (Tuomainen et al., 2013).

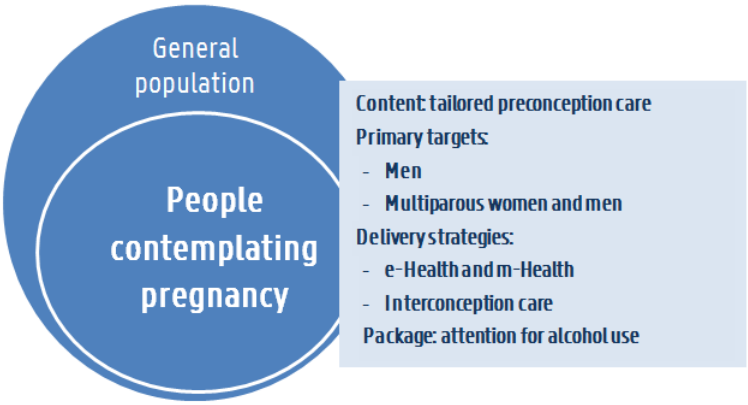
A second, more structural, intervention to improve the awareness and familiarity with preconception health can be a *school-based intervention* (Lassi et al., 2014; Shawe et al., 2015; Temel et al., 2015b; Van Dijk et al., 2017a). Adolescents are a group of interest because their attitude towards health issues and a healthy lifestyle is being formed, and because they are already educated about birth control and reproductive health (Edwards et al., 1997; Mueller et al., 2008; Nelson et al., 2008; Delgado, 2013; OECD, 2013). Moreover, schools provide the opportunity to reach a large number of future parents, including socially vulnerable groups (Fielding and Briss, 2006). As part of this research project, an educational game on preconception health was developed for teachers and students of the third cycle of secondary education. The educational game was developed and

evaluated with an expert group consisting of six teachers, two masters in midwifery, one independent midwife, one staff member of 'Fara' (information and support center on pregnancy choices), one staff member of 'Sensoa' (Flemish Expertise Center for Sexual Health), and one expert in health promotion. Non-participant observations and class discussions in 2 classes were used as input for the product and process evaluation of the educational game. As a result of this evaluation, some minor changes of the wording were made in a few game questions. Subsequently, the final version of the educational game was pilot tested in 6 schools and 14 classes using a pre-post design to assess the process and short-term effect of the educational game on students' awareness, knowledge, and attitude regarding preconception health. Further, large-scale testing, that focuses on long-term effects and include a control group, is needed to assess the lasting effect of the game on the awareness, attitude, and knowledge, and preconception lifestyle changes.

As a third strategy, the CDC recommends that each woman, man, and couple has a lifelong *Reproductive Life Plan (RLP).* A RLP reflects a person's intentions about the timing and number of children someone wants, in a context of personal values and life goals (Johnson et al., 2006). The RLP includes 5 components and questions: (1) Desire to have children: Do you plan to have (more) children?; (2) Number of children desired: If so, how many children do you want?; (3) Timing of children: How long do you plan to wait until your (next) pregnancy?; (4) Spacing of pregnancies: How much space do you plan to have between your pregnancies?; (5) Plan: What do you plan to do to avoid pregnancy until you feel ready to become pregnant, and What do you plan to do to become pregnant in a healthy manner? (Edmonds and Ayres; Moos, 2006). For couples planning to become pregnant within the next year, preconception counseling can be provided (Moos et al., 2008). For those not planning to become pregnant, contraceptive counseling can be offered (Moos et al., 2008). The long-term goal of RLP is to improve the number of planned pregnancies and preconception health (Johnson et al., 2006; Malnory and Johnson, 2011). It would be interesting to explore if a RLP can be used in Flanders to initiate a discussion and education about reproductive health, for example when a patient consults a physician or midwife because of a reproductive health issue (e.g. contraception or pap smears). Primary care settings are ideal to implement such a tool as approximately 80% of the women and 68% of the men in Flanders consult a general practitioner annually (Drieskens and Gisle, 2015). In addition, an individual consult with a healthcare provider is an opportunity for people to have personal questions answered ('individualization'), to receive tailored information ('tailoring'), and to obtain information on their lifestyle and behavioral changes ('feedback'), which are three promising methods for behavioral change (Kok et al., 2016). However, to date there are only a few studies of the implementation and effectiveness of a RLP in clinical practice, and therefore, further research is needed (Edmonds and Ayres; Stern et al., 2015).

Recommendation 2:

Improving preconception lifestyle changes in women and men planning to conceive



The results in this dissertation as well as those in previous studies (Temel et al., 2015b; Van Dijk et al., 2017a) found that women and couples prefer to receive tailored information when planning to conceive. Tailoring can be defined as 'matching the intervention or components to previously measured characteristics of the participant', and is a method that is used to change different determinants of behavior, including knowledge, attitude, awareness and risk perception, which are factors that are associated with the intention to prepare for pregnancy in women and men (in chapters 6 and 7)(Kok et al., 2016).

Although healthcare providers were the preferred source of information about preconception health as shown in this research, the *Internet and (mobile) technologies* offer complementary delivery channels for information (World Health Organization, 2012; Gardiner et al., 2013; Agricola et al., 2014; Van Dijk et al., 2017a; van Dijk et al., 2017b). Especially higher educated women prefer the use of electronic health (e-Health) and mobile health (m-Health), because they belief they are capable of retrieving reliable preconception information. They also find it difficult to addend a healthcare provider due to their busy lives (Poels et al., 2017b). In the USA, an online interactive animated avatar ("Gabby"), and in the Netherlands, a personal m-Health program "Smarter Pregnancy" were found to be effective in promoting positive preconception lifestyle changes (Gardiner et al., 2013; Jack et al., 2015; Van Dijk et al., 2017a; van Dijk et al., 2017b). Both tools provide individual information and coaching, tailored to the risks identified. The results of the online risk assessment questionnaire of the "Smarter Pregnancy" tool can also be used as part of a face-to-face preconception consultation, which was perceived as very useful and timesaving by healthcare providers (Van Dijk et al., 2017a). In Flanders, no m-health or e-health preconception programs are available. The evidence-based website ('gezondzwangerworden.be') only provides general information about preconception health, which may not be as effective or can be ineffective in couples trying to conceive (Van Dijk et al., 2017a). Therefore, it would be interesting to embed an online risk assessment questionnaire in the website, which provides tailored preconception information and recommendations based on the participants responses.

Previous research as well as the present one, report that nulliparous women and men are more receptive to preconception health messages and are more likely to prepare for pregnancy (Wallace and Hurwitz, 1998; Hosli

et al., 2008; Mazza and Chapman, 2010; Murphy et al., 2010; Zhu et al., 2012; Temel et al., 2013; Tuomainen et al., 2013; van der Zee et al., 2013). Additional analyses showed that multiparous women and men were equally or more likely to report preconception risk factors than nulliparous women and men, and thus, can also benefit from preconception lifestyle changes. In addition, the attitude, self-efficacy, and opinion of important others were positively associated with the intention score, while negative emotions and beliefs about preparing for pregnancy were negatively associated with the intention to prepare for pregnancy in multiparous women.

Because *multiparous women and men* seem to be less likely to prepare for pregnancy, interconception care (i.e., preconception care between two pregnancies), can be a strategy to reach this group (Badura et al., 2008; World Health Organization, 2012; DeCesare et al., 2015). One option is to implement interconception care in 'Child and Family' (In Dutch, 'Kind en Gezin') in Flanders. Child and Family provides preventive family care to families with children until the age of 3 years, and is free of charge for all families (Child and Family, n.d.). These preventive care services have high attendance rates, and thus, the potential to reach the majority of the multiparous population (Child and Family, 2015). For example, Child and Family reaches 96% of the target population during the first three months after delivery, and 81% at 12 months (Child and Family, 2015). Motivational interviewing (i.e., a style of communication designed to strengthen personal motivation for and commitment to a specific goal) can be one method to support and encourage preconception behavioral change due to an existing supportive relationship between the client and professionals of Child and Family (Kok et al., 2016). However, several potential barriers to implementation exist, including a main focus on child care rather than maternal care, lack of familiarity with the concept of interconception care in healthcare professionals and women/couples, costs of time and staff investment, lack of guidelines, and the complexity and sensitivity of the topic (Sijpkens et al., 2016). Further implementation research is needed to explore if the implementation of interconception care in Child and Family is possible, and to identify strategies to overcome potential barriers.

Another opportunity to inform multiparous women about preconception health and care is during the postpartum visit. Currently, many healthcare providers view a postpartum visit as a brief consult to address maternal health and potential complications from childbirth, and to discuss contraceptives (Verbiest, 2008). However, the visit can also be viewed as an opportunity to question future pregnancy plans, and if applicable, to inform about preconception health and care. If a woman indicates her family is complete, the healthcare provider should only discuss contraceptives. However, if a woman indicates she may want another child, this could be an opportunity for healthcare providers to emphasize the importance of preconception health during a subsequent pregnancy, and refer to preconception care services. As aforementioned, motivational interviewing can be an effective method to support and encourage preconception health behaviors thanks to the existing relationship between the woman and healthcare provider (Kok et al., 2016). Another possibility to

reach multiparous women and men is spreading preconception health messages through daycare services as 52% of the children between 2 months and 3 years attend formal daycare in Flanders (Child and Family, 2016). It will be important to spread a health message that is relevant and tailored to the multiparous population (Kok et al., 2016).

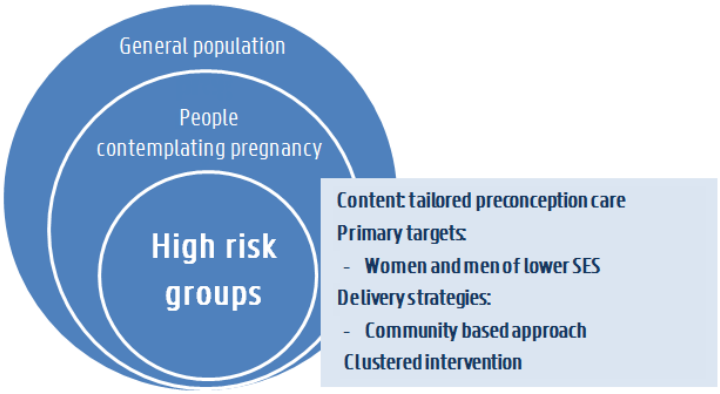
Despite growing evidence for the importance of *men*'s health during the preconception period, the male population is often neglected in preconception health care and research (Agricola et al., 2016; Toivonen et al., 2017). Preconception care and campaigns should be focused on both women and men. The aforementioned recommendations for future interventions, including the role-model-story in a popular television soap opera, school-based intervention, RLP, and m-health and e-health, are also applicable for men. However, more research is needed to tailor it to men's specific needs.

The results of the studies in this dissertation show a high proportion of *alcohol use* in the preconception period and during pregnancy, and are in line with findings of previous research (Green-Raleigh et al., 2005; Anderson et al., 2006; Inskip et al., 2009; Lum et al., 2011; Backhausen et al., 2014; Gormack et al., 2015; Lanting et al., 2015). Additional analyses showed a positive relationship between alcohol consumption prior to pregnancy and high SES, which is also found in other studies (Gisle and Demarest, 2014; Lanting et al., 2015). Alcohol consumption is a habitual behavior, and can be difficult to change because of several factors, such as lack of awareness, lack of self-efficacy, and social norm and pressure (Meurk et al., 2014; Crawford-Williams et al., 2015b). In addition, mixed messages from healthcare providers can contribute to the confusion amongst women with regard to alcohol consumption before and during the pregnancy (Crawford-Williams et al., 2015b, a). Because of the complexity and sensitive nature of the topic, it is a challenge to create public health messages that are motivating but do not result in defensive responses or contribute to negative feelings amongst women who have consumed alcohol before or during the pregnancy, or are unable to abstain from it (France et al., 2014). Self-efficacy and knowledge were the only psychosocial factors that were positively associated with the intention to stop drinking alcohol in the preconception period in women (in chapter 6). None of the factors were associated with the intention in men (in chapter 7), suggesting that other factors may influence their intention to reduce alcohol consumption preconceptionally. The Association for Alcohol and other Drug problems (In Dutch, VAD or 'Vereniging voor Alcohol- en andere Drugproblemen') is a non-profit association that coordinates most of the Flemish organizations that deal with the issues of alcohol, illegal drugs, psychoactive medication, and gambling. In 2012, the Association for Alcohol and other Drug problems launched the campaign "the most beautiful beginning, starts with a stop" (In Dutch, "De mooiste start, begint met een stop") to discourage the use of alcohol, tobacco, illegal drugs, and medication during pregnancy and

breastfeeding (VAD, 2012). It would be interesting to update and expand the campaign to include the preconception period. Furthermore, a study of France et al. (2014) found that a combination of a threat approach based on worry and fear, and a positive (self-efficacy) approach has good potential for use in campaigns targeting abstinence from alcohol during pregnancy. However, this needs to be further investigated in people contemplating pregnancy and the broader public because arousing negative emotions to promote behavior change can sometimes be counter effective (Kok et al., 2016). Additionally, to avoid confusion about the safety and risks of alcohol consumption before and during pregnancy, healthcare providers need to provide clear, evidence-based, and consistent information on alcohol consumption before and during pregnancy.

Recommendation 3:

Reaching women and men of lower SES



The results of this research as well as other studies indicate that women of lower SES have a high prevalence of risk factors for adverse pregnancy outcomes (van der Pal-de Bruin et al., 2008; Harelick et al., 2011; Timmermans et al., 2011; Denny et al., 2012; Weightman et al., 2012; de Graaf et al., 2013; Waelput et al., 2017). Although these women could benefit most from preconception care, literature suggests that they are less likely to use preconception care compared to their lower risk counterparts (Elsinga et al., 2006; de Graaf et al., 2013). Therefore, women and men of lower SES are a priority target population. The additional analyses revealed that self-efficacy, attitude (including negative emotions and beliefs), and risk perception (lack of perceived need) are important factors associated with the intention to prepare for pregnancy in lower educated women, and should be targeted in preconception interventions.

A *community-based approach* is often recommended in the literature because it reaches women who are "hard-to-reach", including women and men of lower SES (Lassi et al., 2014; Shannon et al., 2014a; van Voorst et al., 2015). It would be interesting to develop and implement a community-based intervention in a primary care setting in high-risk neighborhoods. Community health centers (CHCs) offer primary care with attention to health promotion and patient participation in a defined geographical area. These centers have a high accessibility because of the use of a systematic third party payment system, and their openness regardless patients' culture, social or political background (The Organisation of Community Health Centers, n.d.). Implementing a preconception health campaign in CHCs with the provision of preconception care by local

primary healthcare providers can be a strategy to reach women and men of low SES, because the healthcare staff are familiar with the target group, and are known and trusted by women and men (van Voorst et al., 2015). Because of the existing relationship between the clients and healthcare providers, motivational interviewing could be one method to encourage and support preconception health behaviors in people of lower SES (Kok et al., 2016). Modeling with the use of peers as models could be another method to change the attitude and self-efficacy towards preparing for pregnancy. In addition, multidisciplinary collaborations between the CHC and other (local) organizations such as the local infant welfare clinic of Child and Family, hospitals, and other social organizations could improve the effectiveness of a community-based intervention on this matter.

Additional analyses showed that women of lower SES were more likely to smoke, to be overweight or obese, and were less likely to have taken multivitamins/folic acid supplementation before pregnancy. A clustering was found of preconception smoking with preconception alcohol use, a history of drug use, and lack of multivitamin/folic acid intake. These findings as well as results of previous studies on clustering of risks (Poortinga, 2007; Erickson and Arbour, 2012; Page et al., 2012; Ferreira da Costa et al., 2013; Passey et al., 2014; Meader et al., 2016; Mardby et al., 2017) support the potential for interventions targeting multiple risk factors together, and especially among women and men of lower SES. It would be interesting to explore clustering with other lifestyle factors such as nutrition and physical activity in future studies, because these lifestyle behaviors were not assessed in this dissertation.

Figure 1 provides an overview of the aforementioned recommendations for practice and future interventions.

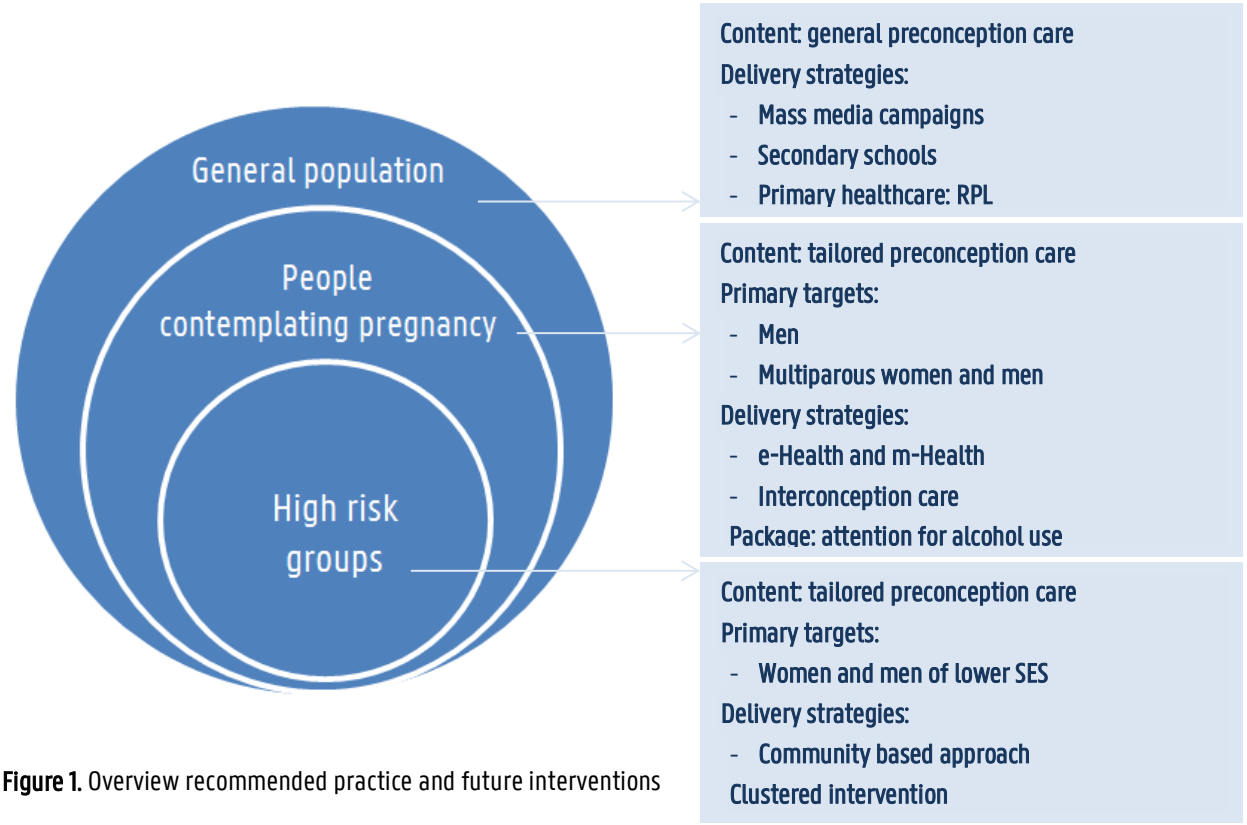


Figure 1. Overview recommended practice and future interventions

4. Recommendations for education and policymakers

The aforementioned recommendations for practice and future preconception interventions were mainly situated at individual, client level. However, individual behavior is also influenced by environmental factors and actors at various levels: interpersonal, organizational, community, and societal levels (Kok et al., 2016). Therefore, based on the insights of this research, the following recommendations are made for education and policymakers:

Recommendation 1:

Expanding the attainment targets in secondary education

The attainment targets on reproductive health in secondary education in Flanders are mainly focused on pregnancy prevention. However, 97% of the adolescents aged 13 to 20 years in Flanders report wanting to have children later on in life (Verschuere and Vandermarliere, 2012). Because the educational system has the potential to reach a large population, including the hard-to-reach groups such as people of lower SES and men, it would be interesting to expand the attainment targets with goals regarding becoming pregnant in a healthy manner and healthy pregnancy.

Recommendation 2:

Strengthening the role of midwives

Midwives can play a prominent role in the provision of preconception care as preconception care is part of primary and preventive reproductive care. In addition, previous research has shown that midwives are the most willing to provide preconception care, and therefore, the most eligible professionals to provide this care (van Voorst et al., 2016; Poels et al., 2017c). However, midwives may need to overcome more barriers compared to general practitioners and gynecologists. In Flanders, most women choose a gynecologist to be their primary healthcare provider during pregnancy (Emons and Luiten, 2001). To strengthen the position of the midwife before, during, and after pregnancy, it is important to raise the awareness of the role of midwives among the general public (e.g., during primary and secondary education, mass media campaigns). In addition, it is important to pay sufficient attention to the concept of preconception care in midwifery education in Flanders. The heads of the midwifery departments in Flanders were assessed in December 2017 about the content and teaching methods regarding preconception care in their curriculum (unpublished data). Although the Flemish education profile of the Bachelor in midwifery includes both knowledge and skills regarding preconception care, the main focus lays on acquiring knowledge. In addition, midwifery students rarely have the opportunity

to offer preconception care during practical training. Therefore, it would be interesting to create opportunities for hands-on learning for midwifery students, for example, by inviting prospective parents to a clinical skills laboratory within the educational setting for a free preconception consultation provided by midwifery students under supervision of teachers.

In Flanders, midwives have few contact with non-pregnant women, which makes it difficult for them to provide preconception care. However, because of a shortened hospital stay in Flanders, there is increased attention to home-based postnatal care provided by primary healthcare providers, including midwives. These changes can be an opportunity to strengthen the role of midwives in primary care, and a chance to provide preconception care in the form of interconception care. In addition, midwives working in a primary care group practice or community health center have the opportunity to reach the non-pregnant population. As general practitioners have regular contact with people of reproductive age, one possible approach could be making arrangements with the local general practitioners for referral to the midwife with regard to preconception care. The collaboration and referral practices between healthcare providers should also be addressed on regional and national level, as lack of clarity on the responsibility for the provision of preconception care was one of the most reported barrier for healthcare providers to deliver preconception care (in chapter 8).

Recommendation 3:

Development of multidisciplinary guidelines on preconception care

In Flanders, the only existing clinical preconception care guidelines were developed mono-disciplinary in 2008, and updated in 2011 by a Flemish association of general practitioners ('Domus Medica') (Samyn et al., 2008; Samyn, 2011). Research on preconception health and care has expanded rapidly in the last decade, and therefore, guidelines on preconception care should be updated. One of the activities of The Belgian Health Care Knowledge Centre (KCE) is the development of good clinical practice guidelines by a multidisciplinary guideline development group using a standard methodology. As part of the national Plan for Evidence Based Practice (EBP) in Belgium, it is suggested that a Network Administrative Organization (NAO) will steer the development of guidelines instead of KCE (Vriesacker et al., 2018). In 2015, KCE developed a Belgian clinical practice guideline concerning recommended clinical assessment and screening tests during pregnancy. This guideline was developed by a multidisciplinary group of practicing healthcare providers and KCE researchers using a standard guideline development methodology consisting of the development of clinical questions, a systematic literature review, and formulating and grading recommendations according to the GRADE approach (Gyselaers et al., 2015). A similar approach is recommended for the development of guidelines regarding preconception care for women and men.

Furthermore, it is also important to develop interdisciplinary recommendations on the organization of preconception care, including the role of different healthcare disciplines in the provision of preconception care, referral, and the collaboration between healthcare providers with regard to preconception care.

Recommendation 4:

Reimbursement of preconception care

The provision of preconception care is not listed in the nomenclature, the so-called list of medical services that are fully or partially refunded by the health insurance. This makes it particularly difficult for midwives to provide preconception care, because midwifery care is only reimbursed in the context of a pregnancy, labor and birth, and postpartum care. Therefore, it is recommended for the Belgian National Institute for Health and Disability Insurance (RIZIV) to add the provision of a preconception consultation to the list of reimbursable services.

5. Recommendations for further research

Several suggestions for preconception interventions were formulated in the paragraphs above, including role-model-story in a popular television, school-based intervention, implementation of the RLP in primary care, e-Health and m-Health tools, and a community based intervention. It is recommended that interventions are developed, implemented, and evaluated using a systematic, and theory- and evidence-based approach, for example, by using the Intervention Mapping protocol. The Intervention Mapping protocol consists of six steps: (1) needs assessment; (2) formulation of change objectives (based on the first step); (3) selection of theory-based intervention methods and practical strategies; (4) development of the intervention program; (5) generating an adoption and implementation plan; and (6) development of an evaluation plan (Bartholomew Eldrigde et al., 2016). The conducted studies of this dissertation can be viewed as a part of the needs assessment process. However, more research is needed on the perspectives of stakeholders on preconception care (e.g., healthcare providers, teachers, policymakers) as all except one of the studies in this dissertation were focused on the perspectives and behavior of reproductive-aged women and men. In addition, it is also recommended to conduct qualitative research with subgroups of the target population to gain insight in their perceptions and experience of barriers to prepare for pregnancy. The use of qualitative research is the most appropriate approach to gain insight into underlying processes and mechanisms of preconception lifestyle changes as qualitative methods explore topics more in-depth and detail than quantitative research. For example, in order to understand why multiparous women, men, and people of lower SES do not prepare for pregnancy, even though they report preconception risk factors. A mentioned above, the ASE model is a social-

cognitive theory that identifies or explains determinants that are important during the early, motivational stage of behavioral change, such as attitude and knowledge (Hoffman et al., 2008, Sniehotta et al., 2014). As previous research suggest, preconception knowledge can increase the intention to perform preconception health behaviors, but does not always lead to actual behavior change (Delissaint and McKyer, 2011; Toivonen, 2017). During the postintentional stage, it is possible that habits, unconscious processes, emotions, or having conflicting or multiple goals also have an influence on the behavioral change (Deutsch and Strack, 2006; Hoffman et al., 2008; Frankish, 2010; Sniehotta et al., 2014). Previous literature suggest that a self-regulation approach might be an effect method to address these factors during the postintentional stage (Plaete et al., 2015; Sheeran, 2002, 2016). Self-regulation can be defined as "a system of conscious personal management of guiding one's own thoughts, behaviors, and feelings to reach goals, using a range of behavioral strategies, such as self-monitoring, action planning, goal setting, and problem solving." (Kahan et al. 2018). it would be interesting to further explore if a self-regulation approach is an effective method to improve preconception health.

For the delivery and prioritization of preconception interventions, it is important to have consensus on the content and organization of preconception care. Until now, there are only few studies on the clinical and economic effectiveness of interventions to reduce preconception risk factors and adverse reproductive outcomes. Therefore, more research is needed on this topic, and especially in specific preconception care domains, such as pregnancy planning, medical and psychiatric conditions, psychosocial stressors, genetic risks, and environmental exposures. To facilitate the comparison and combining of effectiveness studies, it is recommended to develop a core outcome set (COS) for preconception interventions, for example, by using the COMET Handbook for evidence-based COS development (Williamson et al., 2017). Because preconception care has a broad content, it would be interesting to develop a generic data set of core outcomes that can be supplemented with additional outcomes to meet the needs of different target populations, settings or domains of preconception care.

6. Conclusion

Although preconception health and care can improve reproductive health and pregnancy outcomes, most women and men do not adjust their lifestyle before pregnancy, and most healthcare providers do not provide preconception care. Overall, findings of this dissertation showed that preconception health behaviors were influenced by multiple factors at different levels, which supports the use of a socio-ecological approach to preconception interventions in reproductive-aged people.

The original studies in this dissertation showed that the overall interest in preconception health is high, and associated with individual socio-demographic and psychosocial factors. Self-efficacy and attitude were the main factors associated with the intention to prepare for pregnancy in women and men. Women and men of lower socio-economic status, multiparous people, and men, were less intended to prepare for pregnancy. However, these groups would also benefit greatly from preconception lifestyle changes as they were equally or more at risk for adverse pregnancy outcomes. In general, the alcohol consumption before and during pregnancy was high, which is a call for action.

Preconception health behaviors and care were also influenced by environmental factors and actors (e.g. healthcare providers). At healthcare provider level, lack of clarity on the responsibility for the provision of preconception care was one of the most reported influencing factor to deliver preconception care. At organizational and societal level, time, reimbursement, and resources (e.g. guidelines and tools) were important factors influencing the provision of preconception care.

References

Abroms LC, Maibach EW (2008) The effectiveness of mass communication to change public behavior. Annu Rev Public Health 29:219-234.

Agricola E, Pandolfi E, Gonfiantini MV, Gesualdo F, Romano M, Carloni E, Mastroiacovo P, Tozzi AE (2014) A cohort study of a tailored web intervention for preconception care. BMC Med Inform Decis Mak 14:33.

Agricola E, Gesualdo F, Carloni E, D'Ambrosio A, Russo L, Campagna I, Pandolfi E, Tozzi AE (2016) Investigating paternal preconception risk factors for adverse pregnancy outcomes in a population of internet users. Reprod Health 13:37.

Anderson JE, Ebrahim S, Floyd L, Atrash H (2006) Prevalence of risk factors for adverse pregnancy outcomes during pregnancy and the preconception period--United States, 2002-2004. Matern Child Health J 10:S101-106.

Atal S, Cheng C (2016) Socioeconomic health disparities revisited: coping flexibility enhances health-related quality of life for individuals low in socioeconomic status. Health Qual Life Outcomes 14:7.

Atrash HK, Johnson K, Adams M, Cordero JF, Howse J (2006) Preconception care for improving perinatal outcomes: the time to act. Matern Child Health J 10:S3-11.

Backhausen MG, Ekstrand M, Tyden T, Magnussen BK, Shawe J, Stern J, Hegaard HK (2014) Pregnancy planning and lifestyle prior to conception and during early pregnancy among Danish women. Eur J Contracept Reprod Health Care 19:57-65.

Badura M, Johnson K, Hench K, Reyes M (2008) Healthy Start: Lessons learned on interconception care. Women's Health Issues 18:S61-S66.

Barrett G, Smith SC, Wellings K (2004) Conceptualisation, development, and evaluation of a measure of unplanned pregnancy. J Epidemiol Community Health 58:426-433.

Bartholomew Eldrigde LK, Markham CM, Ruiter RAC, Fernandez ME, Kok G, Parcel GS (2016) Planning health promotion programs: an intervention mapping approach, fourth Edition. Hoboken, NJ: Wiley & Sons.

Bodin M, Kall L, Tyden T, Stern J, Drevin J, Larsson M (2017) Exploring men's pregnancy-planning behaviour and fertility knowledge:a survey among fathers in Sweden. Ups J Med Sci 122:127-135.

Boerleider AW, Wiegers TA, Manniën J, Francke AL, Devillé WL (2013) Factors affecting the use of prenatal care by non-western women in industrialized western countries: a systematic review. BMC Pregnancy and Childbirth 13:81.

Bogaerts A (2014) Obesity and pregnancy, an epidemiological and intervention study from a psychosocial perspective. Facts, views & vision in ObGyn 6:81.

Bogaerts A, Van den Bergh BR, Ameye L, Witters I, Martens E, Timmerman D, Devlieger R (2013) Interpregnancy weight change and risk for adverse perinatal outcome. Obstet Gynecol 122:999-1009.

Bonevski B, Randell M, Paul C, Chapman K, Twyman L, Bryant J, Brozek I, Hughes C (2014) Reaching the hard-to-reach: a systematic review of strategies for improving health and medical research with socially disadvantaged groups. BMC Med Res Methodol 14:42.

Bortolus R, Oprandi, NC., Morassutti, FR., Marchetto, L., Filippini, F., Agricola, E., Tozzi, AE., Castellani, C., Lalatta, F., Rusticali, B., & Mastroiacovo, P. (2017) Why women do not ask for information on preconception health? A qualitative study. BMC Pregnancy Childbirth 17.

Buysse A, Enzlin P, Lievens J, T'Sjoen G, Van Houtte M, Vermeersch H, Dewaele A (2014) Sexpert: seksuele gezondheid in Vlaanderen: valorisatierapport. In. Gent: Academia Press.

Campbell JM, Lane M, Owens JA, Bakos HW (2015) Paternal obesity negatively affects male fertility and assisted reproduction outcomes: a systematic review and meta-analysis. Reproductive biomedicine online 31:593-604.

Canady RB, Tiedje LB, Lauber C (2008) Preconception care & pregnancy planning: voices of African American women. MCN Am J Matern Child Nurs 33:90-97.

Charafeddine L, El Rafei R, Azizi S, Sinno D, Alamiddine K, Howson CP, Walani SR, Ammar W, Nassar A, Yunis K (2014) Improving awareness of preconception health among adolescents: experience of a school-based intervention in Lebanon. BMC Public Health 14:774.

Charron-Prochownik D, Sereika SM, Wang SL, Hannan MF, Fischl AR, Stewart SH, Dean-McElhinny T (2006) Reproductive health and preconception counseling awareness in adolescents with diabetes: what they don't know can hurt them. Diabetes Educ 32:235-242.

Child and Family (2015) Annual raport 2015. In. Brussels: Child and Family.

Child and Family (2016) Child in Flanders 2016. In. Brussels: Child and family.

Child and Family (n.d.) Kind en Gezin. We care about young children. In. Brussels: Child and Family.

Chuang CH, Hwang, S. W., McCall-Hosenfeld, J. S., Rosenwasser, L., Hillemeier, M. M., & Weisman, C. S (2012) Primary care physicians' perceptions of barriers to preventive reproductive health care in rural communities. Perspect Sex Reprod Health 44:78-83.

Crawford-Williams F, Steen M, Esterman A, Fielder A, Mikocka-Walus A (2015a) "If you can have one glass of wine now and then, why are you denying that to a woman with no evidence": Knowledge and practices of health professionals concerning alcohol consumption during pregnancy. Women Birth 28:329-335.

Crawford-Williams F, Steen M, Esterman A, Fielder A, Mikocka-Walus A (2015b) "My midwife said that having a glass of red wine was actually better for the baby": a focus group study of women and their partner's knowledge and experiences relating to alcohol consumption in pregnancy. BMC Pregnancy Childbirth 15:79.

Cwiak C, Gellasch T, Zieman M (2004) Peripartum contraceptive attitudes and practices. Contraception 70:383-386.

de Graaf JP, Steegers EA, Bonsel GJ (2013) Inequalities in perinatal and maternal health. Curr Opin Obstet Gynecol 25:98-108.

de Vries H, Dijkstra M, Kuhlman P (1988) Self-efficacy: the third factor besides attitude and subjective norm as a predictor of behavioural intentions. Health education research 3:273-282.

De Vries H, Mudde AN, Dijkstra A, Willemsen MC (1998) Differential beliefs, perceived social influences, and self-efficacy expectations among smokers in various motivational phases. Preventive medicine 27:681-689.

de Walle HE, de Jong-van den Berg LT (2008) Ten years after the Dutch public health campaign on folic acid: the continuing challenge. Eur J Clin Pharmacol 64:539-543.

Dean SV, Lassi ZS, Imam AM, Bhutta ZA (2014) Preconception care: nutritional risks and interventions. Reprod Health 11 Suppl 3:S3.

DeCesare JZ, Jackson JR, Phillips B (2015) Interconception Care Opportunities for Mom and Baby. Obstet Gynecol Surv 70:465-472.

Delgado C (2013) Pregnancy 101: A call for reproductive and prenatal health education in college. Maternal and child health journal 17:240-247.

Delissaint D, McKyer EL (2011) A systematic review of factors utilized in preconception health behavior research. Health Educ Behav 38:603-616.

Denny CH, Floyd RL, Green PP, Hayes DK (2012) Racial and ethnic disparities in preconception risk factors and preconception care. J Womens Health (Larchmt) 21:720-729.

Devries H, Backbier E (1994) Self-efficacy as an important determinant of quitting among pregnant women who smoke: The ø-pattern. Preventive medicine 23:167-174.

Drieskens S, Gisle L (2015) Gebruik van gezondheids- en welzijnsdiensten. In: Gezondheidsenquete 2013. Brussel: Wetenschappelijk Instituut Volksgezondheid.

Deutsch R, Strack F (2006) Duality models in social psychology: From dual processes to interacting systems. Psychological Inquiry 17: 166-172.

Edmonds SW, Ayres L Evolutionary Concept Analysis of Reproductive Life Planning. Journal of Obstetric, Gynecologic & Neonatal Nursing 46:78-90.

Edwards G, Stanisstreet M, Boyes E (1997) Adolescents' ideas about the health of the fetus. Midwifery 13:17-23.

Elsinga J, van der Pal-de Bruin K, le Cessie S, de Jong-Potjer L, Verloove-Vanhorick S, Assendelft W (2006) Preconception counselling initiated by general practitioners in the Netherlands: reaching couples contemplating pregnancy [ISRCTN53942912]. BMC Fam Pract 7:41.

Emons J, Luiten M (2001) Midwifery in Europe: An inventory in fifteen EU-member states: Deloitte & Touche.

Erickson AC, Arbour LT (2012) Heavy smoking during pregnancy as a marker for other risk factors of adverse birth outcomes: a population-based study in British Columbia, Canada. BMC Public Health 12:102.

Fedorowicz AR, Hellerstedt WL, Schreiner PJ, Bolland JM (2014) Associations of adolescent hopelessness and self-worth with pregnancy attempts and pregnancy desire. Am J Public Health 104:e133-140.

Ferreira da Costa F, Benedet J, Leal DB, Altenburg de Assis MA (2013) Clustering of risk factors for non communicable diseases in adults from Florianopolis, SC. Rev Bras Epidemiol 16:398-408.

Fielding JE, Briss PA (2006) Promoting evidence-based public health policy: can we have better evidence and more action? Health Aff (Millwood) 25:969-978.

Floyd RL, Jack BW, Cefalo R, Atrash H, Mahoney J, Herron A, Husten C, Sokol RJ (2008) The clinical content of preconception care: alcohol, tobacco, and illicit drug exposures. Am J Obstet Gynecol 199:S333-339.

France KE, Donovan RJ, Bower C, Elliott EJ, Payne JM, D'Antoine H, Bartu AE (2014) Messages that increase women's intentions to abstain from alcohol during pregnancy: results from quantitative testing of advertising concepts. BMC Public Health 14:30.

Frankish, K., 2010. Dual-process and dual-system theories of reasoning. Philosophy Compass 5: 914-926.

Frayne DJ, Verbiest S, Chelmow D, Clarke H, Dunlop A, Hosmer J, Menard MK, Moos MK, Ramos D, Stuebe A, Zephyrin L (2016) Health Care System Measures to Advance Preconception Wellness: Consensus Recommendations of the Clinical Workgroup of the National Preconception Health and Health Care Initiative. Obstet Gynecol 127:863-872.

Frey KA, Files JA (2006) Preconception healthcare: what women know and believe. Matern Child Health J 10:S73-77.

Fullston T, McPherson NO, Zander-Fox D, Lane M (2017) The most common vices of men can damage fertility and the health of the next generation. The Journal of endocrinology 234:F1-f6.

Gardiner P, Hempstead MB, Ring L, Bickmore T, Yinusa-Nyahkoon L, Tran H, Paasche-Orlow M, Damus K, Jack B (2013) Reaching women through health information technology: the Gabby preconception care system. Am J Health Promot 27:eS11-20.

Gisle L, Demarest S (2014) Alcoholgebruik. Brussel: WIV-ISP.

Gormack AA, Peek JC, Derraik JG, Gluckman PD, Young NL, Cutfield WS (2015) Many women undergoing fertility treatment make poor lifestyle choices that may affect treatment outcome. Hum Reprod 30:1617-1624.

Green-Raleigh K, Lawrence JM, Chen H, Devine O, Prue C (2005) Pregnancy planning status and health behaviors among nonpregnant women in a California managed health care organization. Perspectives on sexual and reproductive health 37:179-183.

Gyselaers W et al. (2015) What are the recommended clinical assessment and screening tests during pregnancy? . In: Good Clinical Practice. Brussels: Belgian Health Care Knowledge Centre (KCE).

Hammiche F, Laven JS, van Mil N, de Cock M, de Vries JH, Lindemans J, Steegers EA, Steegers-Theunissen RP (2011) Tailored preconceptional dietary and lifestyle counselling in a tertiary outpatient clinic in The Netherlands. Hum Reprod 26:2432-2441.

Harelick L, Viola D, Tahara D (2011) Preconception health of low socioeconomic status women: assessing knowledge and behaviors. Womens Health Issues 21:272-276.

Heyes T, Long, S., & Mathers, N. (2004) Preconception care: practice and beliefs of primary care workers. Fam Pract 21:22-27.

Hill N, Hunt E, Hyrkas K (2012) Somali immigrant women's health care experiences and beliefs regarding pregnancy and birth in the United States. J Transcult Nurs 23:72-81.

Higgins, J. A. (2017). Pregnancy Ambivalence and Long-Acting Reversible Contraceptive (LARC) Use Among Young Adult Women: A Qualitative Study. Perspect Sex Reprod Health 49: 149-156.

Hofmann W, Friese M., Wiers RW (2008) Impulsive versus reflective influences on health behavior: A theoretical framework and empirical review. Health Psychology Review 2: 111-137.

Hogan VK, Culhane JF, Crews KJ, Mwaria CB, Rowley DL, Levenstein L, Mullings LP (2013) The impact of social disadvantage on preconception health, illness, and well-being: an intersectional analysis. Am J Health Promot 27:eS32-42.

Hosli EJ, Elsinga J, Buitendijk SE, Assendelft WJ, van der Pal-de Bruin KM (2008) Women's motives for not participating in preconception counseling: qualitative study. Community Genet 11:166-170.

Inskip HM, Crozier SR, Godfrey KM, Borland SE, Cooper C, Robinson SM (2009) Women's compliance with nutrition and lifestyle recommendations before pregnancy: general population cohort study. Bmj 338:b481.

Jack B, Bickmore T, Hempstead M, Yinusa-Nyahkoon L, Sadikova E, Mitchell S, Gardiner P, Adigun F, Penti B, Schulman D, Damus K (2015) Reducing Preconception Risks Among African American Women with Conversational Agent Technology. J Am Board Fam Med 28:441-451.

Jandee K, Lawpoolsri S, Taechaboonsermsak P, Khamsiriwatchara A, Wansatid P, Kaewkungwal J (2014) Customized-Language Voice Survey on Mobile Devices for Text and Image Data Collection Among Ethnic Groups in Thailand: A Proof-of-Concept Study. JMIR Mhealth Uhealth 2:e7.

Johnson K, Posner SF, Biermann J, Cordero JF, Atrash HK, Parker CS, Boulet S, Curtis MG (2006) Recommendations to improve preconception health and health care--United States. A report of the CDC/ATSDR Preconception Care Work Group and the Select Panel on Preconception Care. MMWR Recomm Rep 55:1-23.

Kahan, S., Wilson, D. K., & Sweeney, A. M. (2018). The Role of Behavioral Medicine in the Treatment of Obesity in Primary Care. Medical Clinics 102(1): 125-133.

Kalliala I, Markozannes G, Gunter MJ, Paraskevaidis E, Gabra H, Mitra A, Terzidou V, Bennett P, Martin-Hirsch P, Tsilidis KK, Kyrgiou M (2017) Obesity and gynaecological and obstetric conditions: umbrella review of the literature. Bmj 359:j4511.

Karau SJ, Williams KD (1993) Social loafing: A meta-analytic review and theoretical integration. In: American Psychological Association.

Kok G, Gottlieb NH, Peters GJY, Mullen PD, Parcel GS, Ruiter RA, Fernández ME, Markham C, Bartholomew L (2016) A taxonomy of behaviour change methods: an Intervention Mapping approach. Health Psychology Review 10:297-312.

Korenbrot CC, Steinberg A, Bender C, Newberry S (2002) Preconception care: a systematic review. Matern Child Health J 6:75-88.

Kritsotakis G, Psarrou M, Vassilaki M, Androulaki Z, Philalithis AE (2016) Gender differences in the prevalence and clustering of multiple health risk behaviours in young adults. Journal of advanced nursing 72:2098-2113.

Lan L, Harrison CL, Misso M, Hill B, Teede HJ, Mol BW, Moran LJ (2017) Systematic review and meta-analysis of the impact of preconception lifestyle interventions on fertility, obstetric, fetal, anthropometric and metabolic outcomes in men and women. Hum Reprod 32:1925-1940.

Lanting CI, van Dommelen P, van der Pal-de Bruin KM, Bennebroek Gravenhorst J, van Wouwe JP (2015) Prevalence and pattern of alcohol consumption during pregnancy in the Netherlands. BMC Public Health 15:723.

Lassi ZS, Dean SV, Mallick D, Bhutta ZA (2014) Preconception care: delivery strategies and packages for care. Reprod Health 11 Suppl 3:S7.

Lechner L, Devries H (1995) Starting participation in an employee fitness program: attitudes, social influence, and self-efficacy. Preventive medicine 24:627-633.

Lee SK, Sulaiman-Hill CR, Thompson SC (2014) Overcoming language barriers in community-based research with refugee and migrant populations: options for using bilingual workers. BMC Int Health Hum Rights 14:11.

Lum KJ, Sundaram R, Buck Louis GM (2011) Women's lifestyle behaviors while trying to become pregnant: evidence supporting preconception guidance. Am J Obstet Gynecol 205:203.e201-207.

M'Hamdi H, van Voorst, SF., Pinxten, W., Hilhorst, MT., Steegers, EAP (2017) Barriers in the Uptake and Delivery of Preconception Care: Exploring the Views of Care Providers. Maternal and child health journal 21:21-28.

Mallard SR, Houghton LA (2013) Socio-demographic characteristics associated with unplanned pregnancy in New Zealand: implications for access to preconception healthcare. Australian and New Zealand Journal of Obstetrics and Gynaecology 53:498-501.

Malnory ME, Johnson TS (2011) The reproductive life plan as a strategy to decrease poor birth outcomes. Journal of Obstetric, Gynecologic, & Neonatal Nursing 40:109-121.

Mardby AC, Lupattelli A, Hensing G, Nordeng H (2017) Consumption of alcohol during pregnancy-A multinational European study. Women Birth 30:e207-e213.

Maxson P, Miranda ML (2011) Pregnancy intention, demographic differences, and psychosocial health. Journal of Women's Health 20:1215-1223.

Mazza D, Chapman A (2010) Improving the uptake of preconception care and periconceptional folate supplementation: what do women think? BMC Public Health 10:786.

Mazza D, Chapman, A., & Michie, S (2013) Barriers to the implementation of preconception care guidelines as perceived by general practitioners: a qualitative study. BMC Health Serv Res 13.

McPhie S, Skouteris, H., Millar, L., Olsson, C., Campbell, K., van der Pligt, P., Dodd, J., & Hill, B. (2016) Preconception weight management: an untapped area of women's health. Aust J Prim Health.

Meader N, King K, Moe-Byrne T, Wright K, Graham H, Petticrew M, Power C, White M, Sowden AJ (2016) A systematic review on the clustering and co-occurrence of multiple risk behaviours. BMC Public Health 16:657.

Meurk CS, Broom A, Adams J, Hall W, Lucke J (2014) Factors influencing women's decisions to drink alcohol during pregnancy: findings of a qualitative study with implications for health communication. BMC Pregnancy Childbirth 14:246.

Mitchell EW, Levis DM, Prue CE (2012) Preconception health: awareness, planning, and communication among a sample of US men and women. Matern Child Health J 16:31-39.

Moos M-K (2006) Preconception health: Where to from here? Women's Health Issues 16:156-158.

Moos MK, Dunlop AL, Jack BW, Nelson L, Coonrod DV, Long R, Boggess K, Gardiner PM (2008) Healthier women, healthier reproductive outcomes: recommendations for the routine care of all women of reproductive age. Am J Obstet Gynecol 199:S280-289.

Mortagy I, Kielmann, K., Baldeweg, S. E., Modder, J., & Pierce, M. B (2010) Integrating preconception care for women with diabetes into primary care: a qualitative study. Br J Gen Pract 60:811-821.

Mueller TE, Gavin LE, Kulkarni A (2008) The association between sex education and youth's engagement in sexual intercourse, age at first intercourse, and birth control use at first sex. Journal of adolescent health 42:89-96.

Murphy HR, Temple RC, Ball VE, Roland JM, Steel S, Zill EHR, Simmons D, Royce LR, Skinner TC (2010) Personal experiences of women with diabetes who do not attend pre-pregnancy care. Diabet Med 27:92-100.

Namageyo-Funa A., Rimando M., Brace AM, Christiana RW, Fowles TL., Davis TL, Sealy DA. (2014) Recruitment in qualitative public health research: Lessons learned during dissertation sample recruitment. The Qualitative Report 19: 1-17.

Nelson MC, Story M, Larson NI, Neumark-Sztainer D, Lytle LA (2008) Emerging adulthood and college-aged youth: an overlooked age for weight-related behavior change. Obesity 16:2205-2211.

Noble N, Paul C, Turon H, Oldmeadow C (2015) Which modifiable health risk behaviours are related? A systematic review of the clustering of Smoking, Nutrition, Alcohol and Physical activity ('SNAP') health risk factors. Preventive medicine 81:16-41.

O'Higgins S, McGuire BE, Mustafa E, Dunne F (2014) Barriers and facilitators to attending pre-pregnancy care services: the ATLANTIC-DIP experience. Diabet Med 31:366-374.

OECD (2013) Health at a glance 2013: OECD indicators: OECD publishing.

Page RL, Padilla YC, Hamilton ER (2012) Psychosocial factors associated with patterns of smoking surrounding pregnancy in fragile families. Matern Child Health J 16:249-257.

Passey ME, Sanson-Fisher RW, D'Este CA, Stirling JM (2014) Tobacco, alcohol and cannabis use during pregnancy: clustering of risks. Drug Alcohol Depend 134:44-50.

Plaete, J., De Bourdeaudhuij, I., Verloigne, M., Oenema, A., & Crombez, G. (2015). A self-regulation eHealth intervention to increase healthy behavior through general practice: protocol and systematic development. JMIR research protocols 4(4).

Poels M, van Stel HF, Franx A, Koster MPH (2017a) Actively preparing for pregnancy is associated with healthier lifestyle of women during the preconception period. Midwifery 50:228-234.

Poels M, Koster MPH, Franx A, van Stel HF (2017b) Parental perspectives on the awareness and delivery of preconception care. BMC Pregnancy Childbirth 17:324.

Poels M, Koster MP, Franx A, van Stel HF (2017c) Healthcare providers' views on the delivery of preconception care in a local community setting in the Netherlands. BMC Health Serv Res 17:92.

Poels M, Koster MP, Boeije HR, Franx A, van Stel HF (2016) Why Do Women Not Use Preconception Care? A Systematic Review On Barriers And Facilitators. Obstet Gynecol Surv 71:603-612.

Poels M, Koster, MPH., Franx, A., & van Stel, HF. (2017) Healthcare providers' views on the delivery of preconception care in a local community setting in the Netherlands. BMC Health Serv Res 17.

Poortinga W (2007) The prevalence and clustering of four major lifestyle risk factors in an English adult population. Preventive medicine 44:124-128.

Posner SF, Johnson K, Parker C, Atrash H, Biermann J (2006) The national summit on preconception care: a summary of concepts and recommendations. Matern Child Health J 10:S197-205.

Pratt R, Stephenson J, Mann S (2014) What influences contraceptive behaviour in women who experience unintended pregnancy? A systematic review of qualitative research. J Obstet Gynaecol 34:693-699.

Ramakrishnan U, Grant F, Goldenberg T, Zongrone A, Martorell R (2012) Effect of women's nutrition before and during early pregnancy on maternal and infant outcomes: a systematic review. Paediatr Perinat Epidemiol 26 Suppl 1:285-301.

Raman S, Nicholls R, Ritchie J, Razee H, Shafiee S (2016) How natural is the supernatural? Synthesis of the qualitative literature from low and middle income countries on cultural practices and traditional beliefs influencing the perinatal period. Midwifery 39:87-97.

Ricci E, Al Beitawi S, Cipriani S, Candiani M, Chiaffarino F, Vigano P, Noli S, Parazzini F (2017) Semen quality and alcohol intake: a systematic review and meta-analysis. Reproductive biomedicine online 34:38-47.

Samyn E (2011) Opvolgrapport. Aanbeveling voor goede medische praktijkvoering preconcetie advies. In: Domus Medica.

Samyn E, Bastiaens H, De Sutter A, Van Royen P (2008) Preconceptieadvies. 2008. In: Domus Medica.

Schrander-Stumpel C (1999) Preconception care: challenge of the new millennium? Am J Med Genet 89:58-61.

Schwarz E, Santucci, A., Borrero, S., Akers, A., Nikolasjki, C., & Gold, MA. (2009) Perspectives of primary care clinicians on teratogenic risk counseling Birth Defects Res A Clin Mol Teratol 85:858-863.

Shannon GD, Alberg C, Nacul L, Pashayan N (2013) Preconception health care and congenital disorders: mathematical modelling of the impact of a preconception care programme on congenital disorders. Bjog 120:555-566.

Shannon GD, Alberg C, Nacul L, Pashayan N (2014a) Preconception healthcare delivery at a population level: construction of public health models of preconception care. Matern Child Health J 18:1512-1531.

Shannon GD, Alberg C, Nacul L, Pashayan N (2014b) Preconception healthcare and congenital disorders: systematic review of the effectiveness of preconception care programs in the prevention of congenital disorders. Matern Child Health J 18:1354-1379.

Shawe J, Delbaere I, Ekstrand M, Hegaard HK, Larsson M, Mastroiacovo P, Stern J, Steegers E, Stephenson J, Tyden T (2015) Preconception care policy, guidelines, recommendations and services across six European countries: Belgium (Flanders), Denmark, Italy, the Netherlands, Sweden and the United Kingdom. Eur J Contracept Reprod Health Care 20:77-87.

Shawe J, Delbaere, I., Ekstrand, M., Hegaard, HK., Larsson, M., Mastroiacovo, P., Stern, J., Steegers, E., Stephenson, J., & Tydén, T. (2014) Preconception care policy, guidelines, recommendations and services across six European countries: Belgium (Flanders), Denmark, Italy, the Netherlands, Sweden and the United Kingdom. Eur J Contracept Reprod Health Care:1-11.

Sheeran P (2002) Intention—behavior relations: a conceptual and empirical review. Eur Rev Soc Psychol 12: 1-36.

Sheeran P and Webb TL (2016) The intention–behavior gap. Soc Personal Psychol Compass. 10: 503-518.

Shih H-A, Susanto E (2016) Perceived identifiability, shared responsibility and innovative work behavior. The International Journal of Human Resource Management:1-19.

Sijpkens MK, Steegers EA, Rosman AN (2016) Facilitators and Barriers for Successful Implementation of Interconception Care in Preventive Child Health Care Services in the Netherlands. Matern Child Health J 20:117-124.

Sniehotta, F.F., Presseau, J., Araújo-Soares, V., 2014. Time to retire the theory of planned behaviour. Taylor & Francis.

Squiers L, Mitchell EW, Levis DM, Lynch M, Dolina S, Margolis M, Scales M, Kish-Doto J (2013a) Consumers' perceptions of preconception health. Am J Health Promot 27:S10-19.

Squiers L, Mitchell EW, Levis DM, Lynch M, Dolina S, Margolis M, Scales M, Kish-Doto J (2013b) Consumers' perceptions of preconception health. American Journal of Health Promotion 27:S10-S19.

Stephenson J, Patel D, Barrett G, Howden B, Copas A, Ojukwu O, Pandya P, Shawe J (2014) How do women prepare for pregnancy? Preconception experiences of women attending antenatal services and views of health professionals. PLoS One 9:e103085.

Stern J, Bodin M, Grandahl M, Segeblad B, Axen L, Larsson M, Tyden T (2015) Midwives' adoption of the reproductive life plan in contraceptive counselling: a mixed methods study. Hum Reprod 30:1146-1155.

Stern J, Salih Joelsson L, Tyden T, Berglund A, Ekstrand M, Hegaard H, Aarts C, Rosenblad A, Larsson M, Kristiansson P (2016) Is pregnancy planning associated with background characteristics and pregnancy-planning behavior? Acta obstetricia et gynecologica Scandinavica 95:182-189.

Tang JH, Dominik R, Re S, Brody S, Stuart GS (2013) Characteristics associated with interest in long-acting reversible contraception in a postpartum population. Contraception 88:52-57.

Temel S, Erdem Ö, Voorham T, Bonsel GJ, Steegers E, Denktaş S (2015a) Knowledge on preconceptional folic acid supplementation and intention to seek for preconception care among men and women in an urban city: a population-based cross-sectional study. BMC pregnancy and childbirth 15:340-340.

Temel S, Birnie E, Sonneveld HM, Voorham AJ, Bonsel GJ, Steegers EA, Denktas S (2013) Determinants of the intention of preconception care use: lessons from a multi-ethnic urban population in the Netherlands. Int J Public Health 58:295-304.

Temel S, van Voorst SF, de Jong-Potjer LC, Waelput AJ, Cornel MC, de Weerd SR, Denktas S, Steegers EA (2015b) The Dutch national summit on preconception care: a summary of definitions, evidence and recommendations. J Community Genet 6:107-115.

The Organisation of Community Health Centers (n.d.) Community Health Centers in Flanders. In.

Timmermans S, Bonsel GJ, Steegers-Theunissen RP, Mackenbach JP, Steyerberg EW, Raat H, Verbrugh HA, Tiemeier HW, Hofman A, Birnie E, Looman CW, Jaddoe VW, Steegers EA (2011) Individual accumulation of heterogeneous risks explains perinatal inequalities within deprived neighbourhoods. Eur J Epidemiol 26:165-180.

Tishler CL, Bartholomae S (2002). The recruitment of normal healthy volunteers: a review of the literature on the use of financial incentives. The Journal of Clinical Pharmacology 42: 365-375.

Toivonen KI, Oinonen KA, Duchene KM (2017) Preconception health behaviours: A scoping review. Preventive medicine 96:1-15.

Tough S, Clarke, M., Hicks, M., & Clarren, S. (2004) Clinical practice characteristics and preconception counseling strategies of health care providers who recommend alcohol abstinence during pregnancy. Alcohol Clin Exp Res 28.

Tuomainen H, Cross-Bardell L, Bhoday M, Qureshi N, Kai J (2013) Opportunities and challenges for enhancing preconception health in primary care: qualitative study with women from ethnically diverse communities. BMJ Open 3.

VAD (2012) De mooiste start begint met een stop. In: VAD.

Van der Pal-de Bruin K, De Walle H, Jeeninga W, De Rover C, Cornel M, De Jong-van den Berg L, Schouten J, Brand R, Buitendijk S (2000) The DutchFolic Acid Campaign'-have the goals been achieved? Paediatric and perinatal epidemiology 14:111-117.

van der Pal-de Bruin KM, le Cessie S, Elsinga J, de Jong-Potjer LC, van Haeringen A, Neven AK, Verloove-Vanhorick SP, Assendelft P (2008) Pre-conception counselling in primary care: prevalence of risk factors among couples contemplating pregnancy. Paediatr Perinat Epidemiol 22:280-287.

van der Zee B, de Beaufort ID, Steegers EA, Denktas S (2013) Perceptions of preconception counselling among women planning a pregnancy: a qualitative study. Fam Pract 30:341-346.

Van Dijk MR, Koster MP, Rosman AN, Steegers-Theunissen RP (2017a) Opportunities of mHealth in Preconception Care: Preferences and Experiences of Patients and Health Care Providers and Other Involved Professionals. JMIR Mhealth Uhealth 5:e123.

van Dijk MR, Oostingh EC, Koster MP, Willemsen SP, Laven JS, Steegers-Theunissen RP (2017b) The use of the mHealth program Smarter Pregnancy in preconception care: rationale, study design and data collection of a randomized controlled trial. BMC Pregnancy Childbirth 17:46.

van Voorst S, Plasschaert S, de Jong-Potjer L, Steegers E, Denktas S (2016) Current practice of preconception care by primary caregivers in the Netherlands. Eur J Contracept Reprod Health Care 21:251-258.

van Voorst SF, Vos AA, de Jong-Potjer LC, Waelput AJ, Steegers EA, Denktas S (2015) Effectiveness of general preconception care accompanied by a recruitment approach: protocol of a community-based cohort study (the Healthy Pregnancy 4 All study). 5:e006284.

Vari R, Scazzocchio B, D'Amore A, Giovannini C, Gessani S, Masella R (2016) Gender-related differences in lifestyle may affect health status. Ann Ist Super Sanita 52:158-166.

Verbiest SB (2008) The postpartum visit: An overlooked opportunity for prevention. In: The University of North Carolina at Chapel Hill.

Verschuere S, Vandermarliere S (2012) Kennis rond vruchtbaarheid bij adolescenten en bachelor- en masterstudenten In: Geneeskunde en gezondheidswetenschappen, p 136. Gent: Universiteit Gent.

Vriesacker K, Cambré B, Kokkeler B, van der Kamp B, de Goeij H, Terrier A, Eyssen M, Adriaenssens J (2018) Towards an integrated evidence-based practice plan in Belgium. Part 2 - goverance plan. In: ((HSR) HSR, ed). Brussels: Belgian Health Care Knowledge Centre (KCE).

Waelput AJM, Sijpkens MK, Lagendijk J, van Minde MRC, Raat H, Ernst-Smelt HE, de Kroon MLA, Rosman AN, Been JV, Bertens LCM, Steegers EAP (2017) Geographical differences in perinatal health and child welfare in the Netherlands: rationale for the healthy pregnancy 4 all-2 program. BMC Pregnancy Childbirth 17:254.

Wahabi HA, Alzeidan RA, Esmaeil SA (2012) Pre-pregnancy care for women with pre-gestational diabetes mellitus: a systematic review and meta-analysis. BMC Public Health 12:792.

Wahabi HA, Alzeidan RA, Bawazeer GA, Alansari LA, Esmaeil SA (2010) Preconception care for diabetic women for improving maternal and fetal outcomes: a systematic review and meta-analysis. BMC Pregnancy Childbirth 10:63.

Wakefield MA, Loken B, Hornik RC (2010) Use of mass media campaigns to change health behaviour. The Lancet 376:1261-1271.

Wallace M, Hurwitz B (1998) Preconception care: who needs it, who wants it, and how should it be provided? Br J Gen Pract 48:963-966.

Weightman AL, Morgan HE, Shepherd MA, Kitcher H, Roberts C, Dunstan FD (2012) Social inequality and infant health in the UK: systematic review and meta-analyses. BMJ Open 2.

Weldon E, Gargano GM (1985) Cognitive effort in additive task groups: The effects of shared responsibility on the quality of multiattribute judgments. Organizational Behavior and Human Decision Processes 36:348-361.

Williams L, Zapata LB, D'Angelo DV, Harrison L, Morrow B (2012) Associations between preconception counseling and maternal behaviors before and during pregnancy. Matern Child Health J 16:1854-1861.

Williamson PR, Altman DG, Bagley H, Barnes KL, Blazeby JM, Brookes ST, Clarke M, Gargon E, Gorst S, Harman N, Kirkham JJ, McNair A, Prinsen CAC, Schmitt J, Terwee CB, Young B (2017) The COMET Handbook: version 1.0. Trials 18:280.

Withers M, Kharazmi N, Lim E (2018) Traditional beliefs and practices in pregnancy, childbirth and postpartum: A review of the evidence from Asian countries. Midwifery 56:158-170.

World Health Organization (2012) Meeting to Develop a Global Consensus on Preconception Care to Reduce Maternal and Childhood Mortality and Morbidity. In. Geneva: World Health Organization Headquarters.

Yi Y, Lindemann M, Colligs A, Snowball C (2011) Economic burden of neural tube defects and impact of prevention with folic acid: a literature review. Eur J Pediatr 170:1391-1400.

Young B, Lewis S, Katikireddi SV, Bauld L, Stead M, Angus K, Campbell M, Hilton S, Thomas J, Hinds K (2017) Effectiveness of mass media campaigns to reduce alcohol consumption and harm: a systematic review. The Lancet 390:S98.

Zain MM, Norman RJ (2008) Impact of obesity on female fertility and fertility treatment. Womens Health (Lond) 4:183-194.

Zhu H, Graham D, Teh RW, Hornbuckle J (2012) Utilisation of preconception care in women with pregestational diabetes in Western Australia. Aust N Z J Obstet Gynaecol 52:593-596.

Table 1. Additional analyses investigating the association between education and preconception risk factors

Preconception risk factor	Lower educated[a]	Higher educated[b]	p-value[c]
Additional analyses database preconception needs (n= 242 women)	n= 49	n= 165	
Alcohol consumption	n= 35 (80%)	n= 129 (83%)	0.63
Smoking	n= 11 (25%)	n= 25 (16%)	0.17
Feeling unhealthy	n= 4 (8%)	n= 12 (7%)	0.84
Overweight or obesity	n= 11 (26%)	n= 28 (19%)	0.35
Additional analyses database preconception lifestyle changes (n=430 women)	n=148	n= 280	
Alcohol consumption	n= 64 (45%)	n= 167 (60%)	<0.001
Smoking	n = 29 (20%)	n= 12 (4%)	<0.001
Chronic or serious disease	n= 47 (32%)	n= 71 (25%)	0.17
Complications previous pregnancy	n= 72 (49%)	n= 114 (41%)	0.13
Overweight or obesity	n= 64 (45%)	n= 81 (31%)	<0.001
Folic acid or multivitamin use	n= 102 (69%)	n= 223 (80%)	0.02
Additional analyses database factors women (n=1024 women)[d]	n=136	n=888	
Alcohol consumption	n= 74 (54%)	n= 520 (59%)	0.36
Smoking	n= 25 (18%)	n= 37 (4%)	<0.001
Chronic or serious disease	n= 20 (15%)	n= 56 (6%)	<0.001
Feeling unhealthy	n=2 (2%)	n= 18 (2%)	0.66
Overweight or obesity	n= 52 (41%)	n= 201 (23%)	<0.001
Folic acid use	n= 35 (61%)	n= 289 (84%)	<0.001
Additional analyses database factors men (n=105 men)[d]	n=28 (27%)	n=77 (73%)	
Alcohol consumption	n= 21 (75%)	n= 68 (88%)	0.09
Smoking	n= 11 (39%)	n= 7 (9%)	<0.001
Chronic or serious disease	n= (11%)	n= 4 (5%)	0.32
Feeling unhealthy	n= 0 (0%)	n= 1 (1%)	0.55
Overweight or obesity	n= 7 (25%)	n= 18 (23%)	0.86

[a]primary, secondary or post-secondary education; [b]college or university education; [c]Pearson's Chi-square tests; [d]Non-student population only due to high proportion of students in sample.

Table 2. Summary of simple linear regression analysis with bootstrapping methods (10 000 bootstrapping samples) for psychosocial factors associated with the intention to prepare for pregnancy in lower educated, non-student women (n= 136)

Variable	*B*	SE	p-value	95% CI
Attitude	0.02	0.004	<0.001	0.01 – 0.03
Self-efficacy (overall score)	0.54	0.10	<0.001	0.34 – 0.74
Social influence close social environment	0.004	0.004	0.35	-0.004 – 0.01
Social influence healthcare providers	0.04	0.02	0.03	0.004 – 0.07
Social influence media	0.004	0.02	0.80	-0.03 – 0.04
Importance of others' opinion	0.003	0.01	0.52	-0.01 – 0.01
Knowledge	0.01	0.01	0.47	-0.01 – 0.02
Barrier: health literacy	-0.01	0.003	0.03	-0.01 – -0.001
Barrier: emotions and beliefs	-0.01	0.003	0.001	-0.02 – -0.004
Barrier: religion	-0.01	0.02	0.58	-0.06 – 0.02
Barrier: financial	-0.03	0.02	0.06	-0.06 – -0.001
Barrier: perceived need	-0.04	0.02	0.006	-0.07 – -0.01

Abbreviations, *B*: Beta; CI, Confidence Interval; SE, standard error.

Table 3. Summary of multiple linear regression analysis[a] with bootstrapping methods (10 000 bootstrapping samples) for psychosocial factors associated with the intention to prepare for pregnancy in lower educated women (n=136)

Variable	*B*	SE	p-value	95% CI
Attitude	0.01	0.004	0.001	0.01 – 0.02
Self-efficacy (overall score)	0.47	0.11	<0.001	0.22 – 0.67
Social influence healthcare providers	0.01	0.02	0.56	-0.03 – 0.04
Barrier: health literacy	0.001	0.004	0.75	-0.01 – 0.01
Barrier: emotions and beliefs	-0.01	0.004	0.007	-0.02 – -0.004
Barrier: financial	-0.01	0.02	0.78	-0.04 – 0.03
Barrier: perceived need	-0.03	0.01	0.01	-0.06 – -0.01

[a]All variables with a p-value of ≤ 0.10 in the simple regression analysis were included; R^2= 0.36, Adjusted R^2= 0.32; Abbreviations, *B*: Beta; CI, Confidence Interval; SE, standard error.

Table 4. Additional analyses investigating the association between parity and preconception risk factors

Preconception risk factor	Nulliparous[a]	Multiparous[b]	p-value[c]
Additional analyses database preconception needs (n=242 women)	n= 164 (80%)	n= 40 (20%)	
Alcohol consumption	n= 141 (86%)	n= 24 (60%)	<0.001
Smoking	n= 31 (19%)	n= 5 (13%)	0.34
Feeling unhealthy	n= 12 (7%)	n= 3 (8%)	0.97
Overweight or obesity	n= 41 (25%)	n= 17 (43%)	0.01
Additional analyses database preconception lifestyle changes (n=430 women)	n= 212	n= 217	
Alcohol consumption	n= 117 (56%)	n= 114 (54%)	0.61
Smoking	n= 21 (10%)	n= 20 (9%)	0.80
Chronic or serious disease	n= 60 (28%)	n= 59 (27%)	0.43
Overweight or obesity	n= 71 (35%)	n= 74 (37%)	0.65
Folic acid or multivitamin use	n= 167 (79%)	n= 158 (73%)	0.15
Additional analyses database factors women (n= 1722 women)	n= 1296 (76%)	n= 410 (24%)	
Alcohol consumption	n= 912 (71%)	n= 159 (39%)	<0.001
Smoking	n= 135 (10%)	n= 18 (4%)	<0.001
Chronic or serious disease	n= 104 (8%)	n= 23 (6%)	0.10
Feeling unhealthy	n= 32 (3%)	n= 4 (1%)	0.07
Overweight or obesity	n= 254 (20%)	n= 104 (26%)	0.02
Additional analyses database factors men (n= 304 men)	n= 263 (87%)	n= 40 (13%)	
Alcohol consumption	n= 209 (80%)	n= 31 (76%)	0.74
Smoking	n= 31 (12%)	n= 13 (33%)	0.001
Chronic or serious disease	n= 19 (7%)	n= 3 (8%)	0.36
Overweight or obesity	n= 49 (19%)	n= 10 (26%)	0.36

[a]No previous childbirth; [b]one or more previous childbirths; [c]Pearson's Chi-square tests.

Table 5. Summary of simple linear regression analysis with bootstrapping methods (10 000 bootstrapping samples) for psychosocial factors associated with the intention to prepare for pregnancy in multiparous women (n=410)

Variable	*B*	SE	p-value	95% CI
Attitude	0.02	0.002	<0.001	0.02 – 0.03
Self-efficacy (overall score)	0.53	0.08	<0.001	0.37 – 0.68
Social influence close social environment	0.01	0.003	<0.001	0.007 – 0.02
Social influence healthcare providers	0.04	0.01	<0.001	0.02 – 0.05
Social influence media	0.001	0.08	0.94	-0.02 – 0.02
Importance of others' opinion	0.01	0.004	0.002	0.004 – 0.02
Knowledge	0.02	0.004	<0.001	0.01 – 0.02
Barrier: health literacy	-0.01	0.003	0.003	-0.02 – -0.003
Barrier: emotions and beliefs	-0.01	0.002	<0.001	-0.02 – -0.01
Barrier: religion	0.02	0.02	0.38	-0.02 – -0.05
Barrier: financial	-0.03	0.01	0.01	-0.05 – -0.01
Barrier: perceived need	-0.02	0.01	0.03	-0.04 – -0.002

Abbreviations, *B*: Beta; CI, Confidence Interval; SE, standard error.

Table 6. Summary of multiple linear regression analysis[a] with bootstrapping methods (10 000 bootstrapping samples) for psychosocial factors associated with the intention to prepare for pregnancy in multiparous women (n=410)

Variable	*B*	SE	p-value	95% CI
Attitude	0.02	0.003	<0.001	0.01 – 0.02
Self-efficacy (overall score)	0.44	0.08	<0.001	0.26 – 0.59
Social influence close social environment	0.003	0.003	0.23	-0.002 – 0.009
Social influence healthcare providers	-0.004	0.01	0.70	-0.02 – 0.02
Importance of others' opinion	0.01	0.003	0.04	0.00 – 0.01
Knowledge	0.004	0.004	0.33	-0.004 – 0.01
Barrier: health literacy	0.00	0.003	0.91	-0.01 – 0.01
Barrier: emotions and beliefs	-0.01	0.002	0.001	-0.01 – -0.003
Barrier: financial	-0.002	0.01	0.88	-0.03 – 0.02
Barrier: perceived need	-0.003	0.01	0.71	-0.02 – 0.02

[a]All variables with a p-value of ≤ 0.10 in the simple regression analysis were included; R^2= 0.26, Adjusted R^2= 0.24; Abbreviations, *B*: Beta; CI, Confidence Interval; SE, standard error.

Table 7. Additional analyses investigating clustering of preconception risk factors using Pearson Chi-Square tests

Additional analyses database preconception needs (n=242 women)					
Preconception risk factor	**1.**	**2.**	**3.**	**4.**	**5.**
1. Alcohol use		*p*=0.19	*p*=0.23	*p*=0.16	/
2. Smoking			*p*=0.30	*p*=0.88	/
3. History drug use				*p*=0.35	/
4. Overweight or obesity					/
5. Lack of folic acid/multivitamin use					
Additional analyses database preconception lifestyle changes (n=430 women)					
Preconception risk factor	**1.**	**2.**	**3.**	**4.**	**5.**
1. Alcohol use		*p*=0.01 (+)	*p*=0.10	*p*=0.67	*p*=0.17
2. Smoking			*p*=0.02 (+)	*p*=0.67	*p*<0.001 (-)
3. History drug use				*p*=0.29	*p*=0.66
4. Overweight or obesity					*p*=0.12
5. Lack of folic acid/multivitamin use					
Additional analyses database factors women (n= 1722 women)					
Preconception risk factor	**1.**	**2.**	**3.**	**4.**	**5.**
1. Alcohol use		*p*=0.001 (+)	/	*p*=0.14	*p*=0.55
2. Smoking			/	*p*=0.11	*p*=0.02 (-)
3. History drug use				/	/
4. Overweight or obesity					*p*=0.03 (+)
5. Lack of folic acid/multivitamin use					
Additional analyses database factors men (n= 304 men)					
Preconception risk factor	**1.**	**2.**	**3.**	**4.**	**5.**
1. Alcohol use		*p*=0.22	/	*p*=0.80	/
2. Smoking			/	*p*=0.34	/
3. History drug use				/	/
4. Overweight or obesity					/
5. Lack of folic acid/multivitamin use					

+: positive association; -: negative association

SUMMARY

There is growing evidence that improving women's and men's health before conception can lead to improved maternal and child health outcomes. Although several recommendations to improve preconception health and care have been developed, preconception lifestyle adjustments in reproductive-aged people, and the provision of preconception care by healthcare providers remain low. In an effort to inform and enhance future intervention development for improving preconception health and care, this dissertation provides an overview of (1) preconception needs, pregnancy planning and preconception lifestyle changes, and associated factors among reproductive-aged women and men; and (2) healthcare providers' perspectives on barriers and facilitators to the provision of preconception care.

To date, no studies have assessed the preconception-related needs of reproductive-aged women. However, assessing the needs of the target population is one of the first steps of intervention development. Therefore, the preconception-related information and support needs were investigated among women with a desire to have (more) children. Findings from the first study in **chapter 2** showed that the majority of women (75%) want to receive preconception care, and preferably directly from a healthcare provider. Most women expressed an information need, and few women a support need. Information and support needs were higher among women with specific health conditions. The results of this study are very promising, because they suggest a high interest in preconception health and care (e.g., information on nutrition and nutritional supplements, working conditions, and sports). On the other hand, the interest in some lifestyle topics was low, including on how to obtain a healthy weight, how to increase physical activity, the influence of (secondhand) smoking and alcohol, and fertility and family planning. Most women indicated that they were already fully informed about these topics.

Pregnancy planning is an important part of preconception health and care, because a couple has the opportunity to make lifestyle changes when the pregnancy is planned. Data on pregnancy planning in Flanders are scarce. Therefore, it would be interesting to further investigate this topic. However, no national data registration or questionnaires are available for assessing the prevalence of unplanned pregnancies in Dutch-speaking regions. The 'London Measure of Unplanned Pregnancies' (LMUP) is a valid and reliable instrument to measure pregnancy planning. In **chapter 3**, the LMUP was translated from English into Dutch and its psychometric properties (validity and reliability) were evaluated. In **chapter 4,** the valid and reliable Dutch version of the LMUP was used to assess the prevalence, associated factors, and health outcomes of unplanned pregnancies ending in birth. The results of this study demonstrated that the majority (83%) of the pregnancies were planned, 15% were ambivalent, and 2% unplanned. Unplanned pregnancies were more common among

women of lower socio-economic status and multiparous women (one or more previous childbirths), and were associated with adverse pregnancy outcomes.

Planning a pregnancy is often a first and prerequisite step for preconception lifestyle changes. However, different studies found that women who are consciously planning a pregnancy do not always change their lifestyle before becoming pregnant. In order to gain insight in a broad range of preconception lifestyle changes and associated factors in women having a planned pregnancy, a secondary data analysis of the study about pregnancy planning was conducted in **chapter 5**. Findings from the fourth study in chapter 5 showed that most women who planned their pregnancy (83%) reported one or more lifestyle changes in preparation for pregnancy. Overall, nulliparous women and women with a previous miscarriage were more likely to prepare for pregnancy, while women of lower SES were less likely to prepare for pregnancy. Half of the women obtained advice about preconception health, and most of them received their advice from a professional caregiver. Three-quarters of the women who did not improve their lifestyle before conceiving reported one or more risk factors for adverse pregnancy outcomes.

Another important part of intervention development is to understand which modifiable factors are associated with preconception health behaviors or behavioral intentions. To date, research on factors is limited to studies of socio-demographic factors associated with preconception health behaviors. Hardly any studies have been conducted on modifiable factors associated with preconception health behavior or behavioral intentions in the general population. Therefore, socio-demographic and psychosocial factors associated with the intention to prepare for pregnancy were investigated in women and men in **chapters 6 and 7**, respectively. Findings from the studies in chapters 6 and 7 showed that self-efficacy and attitude were positively associated with a higher intention to prepare for pregnancy in both women and men. In addition, experiencing negative emotions and beliefs about preconception health behaviors such as stress and the belief that preconception health and care is medicalization of conception, was associated with a lower intention to prepare for pregnancy in women and men. Additional factors were found in the study among women. Women with a higher knowledge score, nulliparous women, and those with a normal weight had a higher intention score, while lack of perceived need for preconception lifestyle changes was associated with lower intention to prepare for pregnancy. In the study with men, social influence of the close social environment was the only additional factor associated with a higher intention to prepare for pregnancy. None of the socio-demographic factors were significantly associated with the intention score in the study with men. These findings provide insight into which psychosocial factors are associated with the intention to prepare for pregnancy, and thus, should be targeted in preconception interventions to enhance preconception lifestyle changes.

Literature suggests that healthcare providers have an important influence on women's and men's use of preconception care. To date, an overview of influencing factors on the provision of preconception care is lacking. In chapter 8, a systematic review was conducted to assess the barriers and facilitators to the provision of preconception care by healthcare providers. The results of the systematic review in chapter 8 indicated that the provision of preconception care by healthcare providers is influenced by several client factors as mentioned above (e.g., pregnancy planning, knowledge, attitude), but also by provider, organizational, and societal factors. Lack of clarity on the responsibility for the provision of preconception care was one of the most reported barriers for healthcare providers to deliver preconception care. Several studies showed that healthcare providers perceive preconception care as the responsibility of others rather than their own responsibility. To date, most guidelines recommend a shared responsibility of all (healthcare) providers who have contact with reproductive-aged women and men, which may reduce the sense of individual responsibility and efforts. Time, financial, and resource (e.g., guidelines and tools) constraints were the most important organizational and societal barriers for the provision of preconception care.

SAMENVATTING

In een groeiend aantal studies is aangetoond dat het bevorderen van de gezondheid van vrouwen en mannen vóór de zwangerschap tot betere gezondheidsuitkomsten voor moeder en kind leidt. Ondanks het feit dat er verschillende aanbevelingen geformuleerd zijn voor het bevorderen van de preconceptionele gezondheid en preconceptiezorg, is het eerder uitzonderlijk dat zorgverleners preconceptiezorg aanbieden, of toekomstige ouders zich voorbereiden op een zwangerschap. Om preconceptioneel interventieonderzoek te informeren en bevorderen, geeft dit proefschrift een overzicht van (1) de preconceptionele noden, de zwangerschapsplanning en preconceptionele leefstijlveranderingen bij vrouwen en mannen in de vruchtbare leeftijd. (2) Daarenboven worden de gepercipieerde barrières en facilitatoren voor het aanbieden van preconceptiezorg door zorgverleners in kaart gebracht.

Tot op heden zijn er geen studies beschikbaar die de preconceptionele noden van vrouwen in de vruchtbare leeftijd beschrijven. Het bevragen van de noden van de doelgroep is nochtans één van de eerste stappen bij interventieontwikkeling. Daarom werden de preconceptionele informatie- en begeleidingsnoden onderzocht bij vrouwen met een kinderwens. De bevindingen van deze eerste studie in **hoofdstuk 2** tonen aan dat de meerderheid van de vrouwen (75%) preconceptiezorg wil ontvangen, en bij voorkeur door een zorgverlener. De meeste vrouwen hadden een informatienood en slechts een klein aantal vrouwen had een begeleidingsnood. De informatie- en begeleidingsnoden waren hoger bij vrouwen met bepaalde gezondheidsproblemen. De resultaten van deze studie zijn veelbelovend, aangezien ze een grote interesse in de preconceptionele gezondheid en zorg suggereren, over onder andere voeding en voedingssupplementen, arbeidsomstandigheden en sport. Anderzijds was er weinig interesse in bepaalde leefstijlonderwerpen, zoals de interesse in het bekomen van een gezond gewicht, het bevorderen van de fysieke activiteit, de invloed van (passief) roken en alcohol, en fertiliteit en gezinsplanning. De meeste vrouwen gaven aan dat ze reeds volledig geïnformeerd waren over deze thema's.

Zwangerschapsplanning is een belangrijk onderdeel van de preconceptionele gezondheid en preconceptiezorg, omdat het plannen van een zwangerschap de kans biedt om de gezondheid te bevorderen vóór de zwangerschap. Aangezien gegevens over zwangerschapsplanning in Vlaanderen schaars zijn, zou het interessant zijn om dit thema verder te exploreren. Er is echter geen nationaal registratiesysteem of een vragenlijst beschikbaar voor het meten van de prevalentie van ongeplande zwangerschappen in de Nederlandstalige regio's. De 'London Measure of Unplanned Pregnancies' (LMUP) is een valide en betrouwbaar instrument om zwangerschapsplanning te meten. In **hoofdstuk 3** werd de LMUP vertaald van het Engels naar het Nederlands en werden te psychometrische eigenschappen (validiteit en betrouwbaarheid) van het instrument geëvalueerd. In **hoofdstuk 4** werd de Nederlandstalige, valide en betrouwbare LMUP gebruikt om onderzoek te voeren naar de prevalentie, de geassocieerde factoren en gezondheidsuitkomsten van

ongeplande zwangerschappen eindigend in een geboorte. De resultaten van deze studie tonen aan dat de meerderheid van de zwangerschappen gepland was (83%), 15% was ambivalent gepland, en 2% ongepland. Een ongeplande zwangerschap kwam frequenter voor bij vrouwen met een lager socio-economisch profiel en bij meerbarende vrouwen, en was geassocieerd met negatieve zwangerschapsuitkomsten.

Het plannen van een zwangerschap is vaak de eerste en noodzakelijke stap voor het doorvoeren van preconceptionele leefstijlveranderingen. Verschillende studies tonen echter aan dat het bewust plannen van een zwangerschap niet noodzakelijk gepaard gaat met leefstijlveranderingen vóór de zwangerschap. Om inzicht te krijgen in preconceptionele leefstijlveranderingen en de geassocieerde factoren bij vrouwen met een geplande zwangerschap, werd er een secundaire data-analyse uitgevoerd op basis van de studie naar zwangerschapsplanning (**hoofdstuk 5**). De bevindingen van hoofdstuk 5 tonen aan dat de meeste vrouwen met een geplande zwangerschap (83%) één of meerdere preconceptionele leefstijlveranderingen rapporteerden. Eerstbarende vrouwen en vrouwen met een voorgeschiedenis van een miskraam waren meer geneigd om preconceptionele leefstijlveranderingen door te voeren, terwijl vrouwen met een lager socio-economisch profiel minder geneigd waren om zich voor te bereiden op de zwangerschap. Ongeveer de helft van de vrouwen had advies ingewonnen over gezond zwanger worden en de meeste van hen werden geïnformeerd door een zorgverlener. Driekwart van de vrouwen die geen leefstijlveranderingen rapporteerden, hadden 1 of meerdere risicofactoren voor een negatieve zwangerschapsuitkomst.

Een ander belangrijk onderdeel van interventieontwikkeling is het in kaart brengen van de veranderbare factoren die geassocieerd zijn met gezondheidsgedragingen of gedragsintenties. Tot op heden is onderzoek naar factoren van preconceptionele gezondheidsgedragingen beperkt tot geassocieerde socio-demografische factoren. Aangezien onderzoek naar veranderbare factoren schaars is, werd er in **hoofdstuk 6 en 7** onderzoek gevoerd naar de socio-demografische en psychosociale factoren die geassocieerd zijn met de intentie tot preconceptionele leefstijlveranderingen bij vrouwen en mannen. De bevindingen van de studies in hoofdstuk 6 en 7 tonen aan dat de eigen-effectiviteit en attitude bij zowel vrouwen als mannen positief geassocieerd waren met de intentie tot gedragsverandering in de periode vóór de zwangerschap. Het ervaren van negatieve gevoelens en gedachten over preconceptionele gezondheidsgedragingen, zoals stress en het idee dat preconceptionele gezondheid en –zorg een medicalisering is van de conceptie, waren geassocieerd met een lagere intentiescore bij vrouwen en mannen. Een lagere kennisscore en geen nood hebben aan preconceptionele leefstijlveranderingen was geassocieerd met een lagere intentiescore bij vrouwen. Eerstbarende vrouwen en vrouwen met een normaal gewicht waren meer geneigd om zich voor te bereiden op een zwangerschap. In de studie met mannen was het ervaren van een sociale invloed van de dichte omgeving

positief geassocieerd met de intentie tot preconceptionele leefstijlveranderingen. Geen enkele socio-demografische factor was significant geassocieerd met de intentiescore bij mannen. De bevindingen van deze studie geven inzicht in welke veranderbare factoren geassocieerd zijn met de intentie tot leefstijlveranderingen vóór de zwangerschap. Toekomstige preconceptionele interventies kunnen zich richten op deze factoren om preconceptionele leefstijlveranderingen te bevorderen.

Bevindingen uit voorgaande studies suggereren dat zorgverleners een belangrijke invloed hebben op het gebruikmaken van preconceptiezorg door vrouwen en mannen. Tot op heden is er geen overzicht beschikbaar van factoren die een invloed hebben op het aanbieden van preconceptiezorg door zorgverleners. In **hoofdstuk 8** werd er een systematische literatuurstudie uitgevoerd om na te gaan welke belemmerende en bevorderende factoren een invloed hebben op het aanbieden van preconceptiezorg door zorgverleners. De resultaten van de systematische review in hoofdstuk 8 tonen aan dat het aanbieden van preconceptiezorg beïnvloed wordt door verschillende cliëntgerelateerde factoren, zoals ook hierboven werd beschreven (o.a. zwangerschapsplanning, kennis en attitude), maar ook door zorgverlener-, organisatorische-, en maatschappelijke factoren. Gebrek aan verantwoordelijkheid was één van de meest gerapporteerde barrières voor het aanbieden van preconceptiezorg. Verschillende studies toonden aan dat zorgverleners preconceptiezorg percipiëren als de verantwoordelijkheid van anderen. Tot op heden bevelen de meeste richtlijnen een gedeelde verantwoordelijk aan tussen alle (zorg)verleners die contact hebben met vrouwen en mannen in de vruchtbare leeftijd, wat het gevoel van individuele verantwoordelijkheid kan reduceren. Gebrek aan tijd, geld en middelen (zoals richtlijnen en tools) waren de belangrijkste organisatorische en maatschappelijke barrières voor het aanbieden van preconceptiezorg door zorgverleners.

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CURRICULUM VITAE

Personalia

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20 januari 1987	**Bruges**

Education

2016 – 2018	Specific teacher education - CVO Panta Rhei
2008 – 2010	Master of Science in Health Education and Health Promotion – Ghent University
2005 – 2008	Bachelor in Midwifery – Vives Bruges
1999 – 2005	Secondary education, science-mathematics, Sint-Andreaslyceum Sint-Kruis

Work experience

2013 – 2018	PhD student – University Centre for Nursing and Midwifery, Departement of Public Health, Ghent University
2010 – 2013	Scientific staff – University Centre for Nursing & Midwifery, Department of Public Health, Ghent University
2010	Midwife, St-Lucas Hospital Bruges

Additional training

2014	Medical and scientific writing, doctoral Schools – Ghent University
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Publications

Publications in international journals included in the science citation index

Goossens, J., De Roose, M., Van Hecke, A., Goemaes, R., Verhaeghe, S., Beeckman, D. (2018). Barriers and facilitators to the provision of preconception care by health care providers: a systematic review. *International Journal of Nursing Studies*. In Press. https://doi.org/10.1016/j.ijnurstu.2018.06.009. Category NURSING: 1/114 (Q1) – IF: 3.755.

Goossens J., Beeckman D., Van Hecke A., Delbaere I., Verhaeghe S. (2017). Preconception lifestyle changes in women with planned pregnancies. *Midwifery*, 33: 64 – 72. DOI: 10.1016/j.midw.2015.10.012. Impact Factor: 1.95; NURSING: 13/114 (Q1).

Goossens J., Van Den Branden Y., Van der Sluys L., Delbaere I., Van Hecke A., Verhaeghe S., Beeckman D. (2016). The prevalence of unplanned pregnancy ending in birth, associated factors, and health outcomes. *Human Reproduction*, 31(12): 2821 – 2833. DIO: 10.1093/humrep/dew266. Impact factor: 5.02; OBSTETRICS & GYNECOLOGY: 5/79 (Q1).

Goemaes, R., Beeckman, D., **Goossens,** J., Shawe, J., Verhaeghe, S., & Van Hecke, A. (2016). Advanced midwifery practice: An evolutionary concept analysis. Midwifery, 42, 29-37. DOI: 10.1016/j.midw.2016.09.004. Impact Factor: 1.95; NURSING: 13/114 (Q1).

Goossens, J., Delbaere, I., Dhaesens, C., Willems, L., Van Hecke, A., Verhaeghe, S., Beeckman, D. (2015). Preconception-related needs of reproductive-aged women. *Midwifery*, 33:64-72. DIO: 10.1016/j.midw.2015.10.012. Impact factor: 1.86; NURSING: 13/116 (Q1)

Goossens, J., Delbaere, I., Beeckman, D., Verhaeghe, S., Van Hecke, A. (2015). Communication Difficulties and the Experience of Loneliness Among Cancer Patients Dealing with Fertility Issues: a Qualitative Study. *Oncology Nursing Forum,* 42(1):34-43. DOI: 10.1188/15.ONF.34-43. Impact factor: 2.71; NURSING: 2/116 (Q1)

Goossens, J., Delbaere, I., Van Lancker, A., Beeckman, D., Verhaeghe, S. & Van Hecke, A., (2013). Cancer patients' and professional caregivers' needs, preferences and factors associated with receiving and providing fertility-related information: a mixed-methods systematic review. *International journal of Nursing studies*, 51(2), 300 – 3019. DOI: 10.1016/j.ijnurstu.2013.06.015. Impact factor: 2.25; NURSING: 3/105 (Q1)

Van Lancker, A., Verhaeghe, S., Van Hecke, A., Vanderwee, K., **Goossens, J.,** & Beeckman, D. (2012). The association between malnutrition and oral health in the elderly residing in a long-term care facility: a systematic review. *International Journal of Nursing Studies*, 49(12): 1568-1581.Impact factor: 2.08; NURSING: 5/104 (Q1)

Presentations

Oral presentations

Goossens J., Beeckman D., Delbaere I., Van Hecke A., Verhaeghe S., (2017). Preconception health behavior among women with planned pregnancies: findings from a study in Flanders, Belgium. CARE4 International *Scientific Nursing and Midwifery Congress, 9 februari 2017, UZ Antwerpen.*

Goossens J., Van Den Branden Y., Van der Sluys L., Delbaere I., Van Hecke A., Verhaeghe S., Beeckman D. (2017). The prevalence of unplanned pregnancy ending in birth, associated factors, and health outcomes. CARE4 International *Scientific Nursing and Midwifery Congress, 9 februari 2017, UZ Antwerpen.*

Goossens, J., Beeckman, D., Delbaere, I., Van Hecke, A., Verhaeghe, S., (2016). Preconception care: status. *International Organization of Midwifery, 12 oktober 2016, Gent.*

Goossens, J., Delbaere, I., Dhaesens, C., Willems, L., Van Hecke, A., Verhaeghe, S., Beeckman, D. (2015). Needs and factors that have an influence on the intention to use preconception care among Flemish women. *Annual meeting of European Society of Human Reproduction & Embryology, 16 juni 2015, Lissabon.*

Goossens, J., Verhaeghe, S., Beeckman, D. (2015). Overzicht van onderzoek binnen preconceptiezorg. *Studiedag 'preconceptiezorg breed bekeken', 26 februari 2015, Vives Kortrijk.*

Goosens, J., Delbaere, I., Dhaesens, C., Willems, L., Van Hecke, A., Verhaeghe, S., Beeckman, D. (2015). Preconception-related needs of reproductive-aged women. *CARE4 International Scientific Nursing and Midwifery Congress, 5 februari 2015, UZ Antwerpen.*

Goossens, J., Delbaere, I., Decoene, E., Soetens, J., Grypdonck, M., Verhaeghe, S., Van Hecke, A. (2014). Vruchtbaarheid en kanker: inzichten en vergeet-me-niet aanbevelingen. *Les postgraduaat oncologie, Vives, 12 juni 2014.*

Goossens, J., Delbaere, I., Decoene, E., Soetens, J., Grypdonck, M., Verhaeghe, S., Van Hecke, A. (2014). Vruchtbaarheid en kanker: inzichten en vergeet-me-niet aanbevelingen. *Symposium "Oncofertiliteit", 22 mei 2014, UZ Gent.*

Goossens, J., Delbaere, I., Decoene, E., Soetens, J., Grypdonck, M., Verhaeghe, S., Van Hecke, A. (2014). Vruchtbaarheid en kanker: het verhaal van patiënten en hulpverleners. *Symposium "Zorg om de oncologische patiënt", 25 februari 2014, UZ Gent.*

Goossens, J., Delbaere, I., Decoene, E., Soetens, J., Grypdonck, M., Verhaeghe, S., Van Hecke, A. (2013). Vruchtbaarheid en kanker: inzichten en vergeet-me-niet aanbevelingen voor hulpverleners. *Congres: "2e Congres in de psychosociale oncologie 'Psychosocial research and practice'", 19 december 2013, Cédric Hèle Instituut.*

Goossens, J., De Sutter, A., Willems, L., Van Hecke, A., Verhaeghe, S., Delbaere, I. (2012). Development of a needs assessment instrument for couples planning a pregnancy. *2nd European Congress on Preconception Care and Health - 4 & 5 oktober 2012, Rotterdam (Oral presentation)*

Delbaere, I., **Goossens, J**., Van Hecke A., Verhaeghe, S., De Sutter, P., Temmerman, P. (2012). The preconception consultation at University Hospital Ghent: evaluation of approachability and results of follow-up *2nd European Congress on Preconception Care and Health - 4 & 5 oktober 2012, Rotterdam*

Poster

Goossens J., Beeckman D., Van Hecke A., Delbaere I., Verhaeghe S., (2017). Preconception behavior among women with planned pregnancies: a study in Flanders, Belgium. CARE4 International *Scientific Nursing and Midwifery Congress, 9 februari 2017, UZ Antwerpen.*

Goossens, J., Delbaere, I., Van Hecke, A., Verhaeghe, S. (2012). Fertility and –preservation in cancer patients: Needs and experiences from caregivers' and patients' perspectives*. OncoPoint research seminar, May 23rd 2012, Ghent University Hospital, Ghent (Storm Session and Poster presentation).*